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frontispiece

A laboratory technician determines blood-clotting time, information necessary to the safe use of anticoagulant drugs. (See story of the American Heart Association on page 115.)

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PUBLIC HEALTH REPORTS

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
MARION B. FOLSOM, *Secretary*

PUBLIC HEALTH SERVICE
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Epidemiology of Leukemia

By GILCIN F. MEADORS, M.D.

MOST definitions of leukemia incorporate the concept that it is an "invariably fatal systemic disease of unknown etiology primarily involving the blood forming organs . . . characterized by widespread, rapid, and disorderly proliferation of the leukocytes and their precursors and by the presence, almost without exception, at some time during the course of the disease, of immature leukocytes in the blood often in very large numbers" (*1*).

Leukemia is a rare disease, but because of its fatal character it exceeds as a cause of death many of the acute communicable diseases such as diphtheria, smallpox, and poliomyelitis. In 1950, it was the stated cause of 8,845 deaths out of a total of 210,723 deaths from cancer and 1,452,454 deaths from all causes. The unknown nature of its causation, the fact that it occurs most frequently in the acute form in childhood, and its invariably fatal outcome contribute to making leukemia a matter of interest and concern to the layman and a challenge to the scientist, the clinician, and the epidemiologist somewhat out of proportion to its position in the list of causes of death.

Dr. Meadors, now a private practitioner in Damascus, Md., was formerly chief of the Technical Services Branch of the National Cancer Institute, National Institutes of Health, Public Health Service. This is a revision of a paper presented before the Public Health Cancer Association at the 81st Annual Meeting of the American Public Health Association in New York, November 9, 1953.

Clinical Characteristics

Leukemia occurs at all ages. It has been reported as present at birth (*2*) or as diagnosed during the neonatal period (*3*), and it has been recorded in one woman who was 102 years old (*4*). It may be fatal in a few weeks, as far as the clinical course is concerned, yet one patient was observed for 29 years with the disease in its chronic form (*5*).

Morphologically, leukemia is classified as myeloid, lymphoid, or monocytic, according to the type of leukocyte or precursor involved. It is further grouped into acute and subacute, or chronic, types, according to the relative frequency of the immature or blast forms appearing in the bone marrow or blood. The percentage of patients with an unclassified cell type of acute leukemia varies from hospital to hospital and ranges from nearly zero to 40 percent or more. Aleukemic forms of the disease, with normal or depressed total leukocyte counts in the circulating blood, have been described for most cell types.

Leukemia is related to other lymphomas, such as lymphosarcoma, which occasionally may first become manifest clinically as leukemia or which may have a transient or terminal leukemic phase (*2*). Leukemia also occurs terminally in 20 to 30 percent of the patients with polycythemia vera. Hemorrhage, anemia,

intercurrent infection and toxemia, and symptoms arising from enlargement of the liver and spleen are characteristic of the clinical disease. The rapidity of development and severity of symptoms, the number and duration of remissions, and the length of survival have classically distinguished the acute from the chronic clinical course. Degree of response to specific chemotherapeutic agents may provide an additional dimension for differentiation of subgroups.

The relative frequency of the acute and the chronic forms in both clinical and autopsy series suggests that the acute form is more common in children and youths, and the chronic form occurs more frequently in older persons. Frequency distributions from these and similar sources cannot be related to the population at risk. The apparent difference in age selection of acute leukemia, in particular, may be of a different order from that currently accepted.

Problems of Classification

As pointed out by Gilliam (*6*), the classification of leukemia in the sixth revision of the International Lists of Diseases and Causes of Death (1948) is probably as detailed as is realistic for routine recording of deaths. It provides for classification of leukemia by cell type, but no distinction is made between the acute and chronic forms of these entities. Until 1910, the International List included all leukemia under the general term of "anemia." From that date Hodgkin's disease was tabulated under "leukemia" until 1921, when the two entities were given separate rubrics. Between 1938 and 1948, the two forms "leukemia" and "aleukemia" were distinguished by the International List but with no indication of cell type or chronicity.

Sacks and Seeman (*7*) explored the sources of error in the reporting of leukemia as a cause of death. They came to the conclusion that the system of diagnosis and of classification, as established by the fifth revision of the International List (1938), led to an understatement of deaths from leukemia, but that joint cause selection had no significant effect. Congenital leukemia is known to be overlooked as a cause of neonatal death (*2*). Other diagnoses, which possibly have been overlooked, are leukemia occurring in elderly patients who have died presumably from other diseases of old age and in patients of all ages who have died of a fulminating infection relating to an undiagnosed acute leukemia. This latter category has probably decreased in importance because of the effectiveness of antibiotic therapy. Beneficial results from the use of cortisone and chemotherapeutic agents in addition to radiation and blood transfusions make it likely that in the future a larger proportion of patients with leukemia, or suspected leukemia, will be hospitalized at some time during the course of their illness. Increased specificity of diagnosis can be expected and should result in more accurate death certification, followed by less underrecording of leukemia as a cause of death.

In his search for clues to the etiology of leukemia, the epidemiologist must almost perforce be dependent on records designed and assembled for other specific purposes. Sources for clues to the epidemiology of leukemia include mortality records, cancer case registers and surveys, clinical and laboratory records, and results of studies of experimental leukemia. The characteristics of leukemia as determined from these sources are at times confusing, if not contradictory, and the question may be raised as to whether "the leukemias" is not a more appropriate term than "leukemia." The acute and chronic forms of leukemia exhibit such wide differences in the clinical course, response to therapy, age selection, and micropathology that they may be considered as different entities, with some manifestations common to both.

Vital and clinical records should not be neglected as sources of leads for more detailed and specific studies despite the problems involved in diagnosis and classification of individual cases of leukemia and questions that may be raised about the adequacy of such records. The trend in mortality from leukemia, as the stated cause of death in the United States registration area, has been reviewed by Sacks and Seeman (*7*), who reported an increase in the crude rate from 19 per 1 million population in 1900 to 37 per 1 million in 1940. Trends in mortality rates from leukemia, according to sex, are shown in figure 1 for 1933–50. This period is used because the United States death

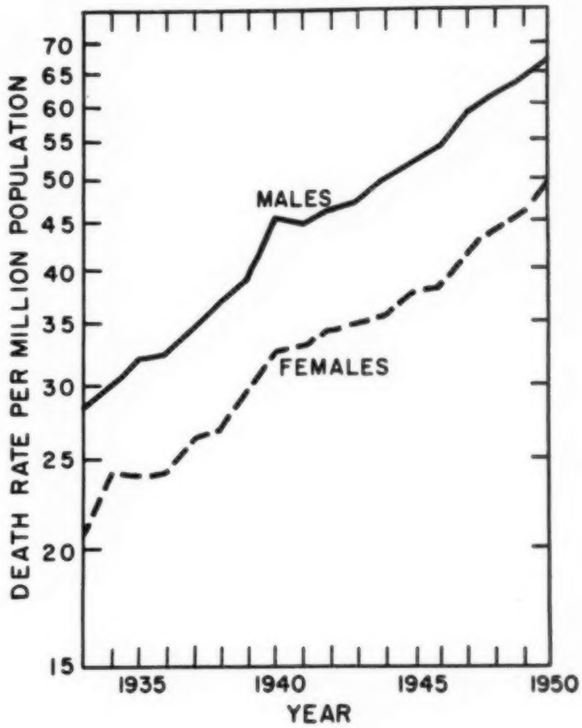
registration area, prior to 1933, did not include all of the States and the District of Columbia. The mortality rate has increased during nearly every one of those 18 years, and the rate of increase has remained nearly constant for the entire period. In 1950, the rate for all males was 67.4 and for females 49.8 per 1 million.

The question as to whether this observed increase is "real," that is, whether the risk of an individual developing leukemia is increasing or whether the risk is only "apparently" increasing, is the subject of considerable discussion. It is agreed that a portion of the increase is apparent and due to the changing composition of the population, with a relative increase in the numbers and proportion of older individuals who are known to have an increased risk for developing leukemia. This part of the apparent increase in rate may be estimated and an adjustment of rates made. Another part of the apparent increase is generally attributed to increased, improved, and more frequently used diagnostic services for leukemia, and to more public and professional interest in the disease. The influence of the latter factors has not been evaluated numerically, except for exceedingly crude estimation. And the amount of increase is dependent, to a great degree, on the convictions of the observer. Thus, when the question is restated, "Would you estimate that improved medical care and public and professional interest account for much or little of the increase in mortality from leukemia?" it is obvious that either less equivocal evidence or a direct method for estimating the real increase is required.

Age, Race, and Sex Selection at Death

Gilliam (*6*) has recently published an analysis of leukemia deaths by age, race, and sex, based on United States mortality experience during 1949. He showed that the risk of death from lymphatic leukemia was higher during each of the first two decades of life than during the third and fourth decades combined. From the fifth decade on there is a marked increase of risk with longevity. The risk of death from myelocytic leukemia is less than that from lymphatic, and there is no secondary peak in risk during childhood. The risk of death

Figure 1. Annual death rate per million population for all forms of leukemia, by sex, United States, 1933–50.



from all forms of leukemia is higher for males than for females in both white and nonwhite races, the male to female ratio being 1.5 for each race. The ratio of white to nonwhite death rates for all forms of leukemia is 2.0 for males and 2.3 for females.

Urban-Rural Distribution

The reported mortality from all forms of leukemia and aleukemia during the years 1944–48 was examined for urban-rural differences in the United States. Average annual mortality rates, according to age and sex, were calculated for urban and rural residence (see table). Urban rates are almost consistently higher than corresponding rural rates for each age and sex group. In diseases for which the precision of diagnosis is dependent on more difficult or specialized procedures, this type of phenomenon is usually ascribed to the relative availability of medical care.

When these data are plotted on a semilogarithmic grid (fig. 2), a changing order of dif-

Average annual mortality rates from all forms of leukemia per 1 million white population for urban and rural residents, according to age and sex, United States, 1944–48.

Age in years	Male		Female	
	Urban	Rural	Urban	Rural
0–4	61. 56	50. 17	54. 81	40. 99
5–9	38. 30	25. 60	26. 84	19. 36
10–14	27. 43	15. 48	19. 93	14. 31
15–19	30. 61	21. 97	17. 10	12. 76
20–24	20. 29	21. 58	13. 96	12. 95
25–29	22. 50	17. 19	17. 26	12. 45
30–34	31. 26	20. 47	22. 65	15. 33
35–39	30. 20	20. 52	28. 06	18. 81
40–44	39. 43	29. 60	30. 28	23. 15
45–49	57. 28	37. 75	47. 05	32. 14
50–54	86. 00	59. 42	66. 17	42. 59
55–59	126. 32	89. 21	97. 85	63. 07
60–64	180. 08	115. 93	104. 74	86. 75
65–69	228. 45	144. 67	140. 30	102. 53
70–74	292. 71	200. 52	169. 89	127. 57
75 and over	318. 93	184. 13	174. 39	107. 14
Total	67. 35	45. 83	48. 39	32. 75

ference in rates at different ages becomes apparent. The greatest urban-rural differences in mortality rates for white males appear to be at ages 10–14 and 30–39; for white females at ages 10–19 and 25–39. The least urban-rural differences in rates for white male mortality appear to be at ages 20–24 and 0–9; for white females at ages 20–24 and 0–9. The white male experience was the largest in total number and was selected for statistical examination of the variability of urban to rural ratios. Analysis of variance techniques were applied, and the variation between age groups was significantly greater than could be accounted for by chance alone. This does not appear consistent with the hypothesis that urban-rural differences in leukemia mortality are attributable for the most part to urban-rural variation in the availability of medical care.

Clemmesen, Busk, and Nielsen (*8*) examined the topographical distribution of leukemia in Denmark and published diagrams showing the trend of rates of mortality attributed to all forms of leukemia for the years 1931–45, by sex and by density of population at place of residence. Age composition was not considered. Rates for residents of rural areas tended to be lower than for residents of the capital, with provincial towns somewhere in between. Annual fluctuations in the rates were wide, however, and the tendency in these data toward an urban-rural difference is not remarkable.

Socioeconomic Distribution of Deaths

From rather meager published data, the higher death rates for leukemia appear to occur more commonly in the more prosperous segments of the population. The two pieces of evidence cited display quite similar trends of increase in rates from lower to higher economic status.

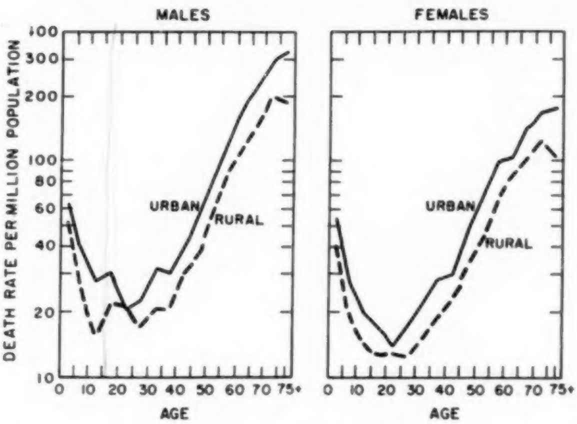
The older data are from the registrar general's report dealing with mortality in England and Wales during the years 1930–32 (*9*, *10*). Decedents were classified according to recorded occupation into five classes: class I, professional; class III, skilled artisan; class V, laborers and unskilled workers; classes II and IV, intermediate and mixed types of occupations or types not readily assignable to classes on either side. Deaths of men and married women only were considered in the analysis. The men were classified according to their own occupation and the women according to the occupation of their husbands. Standard mortality ratios for leukemia deaths in each class exhibited a progressive decrease from class I to class V. This trend is directly opposite to similar ratios computed for deaths from all forms of cancer.

More recently, Sacks and Seeman (*7*) grouped census tract populations into eight classes according to median monthly housing rental and computed average annual death rates from all forms of leukemia for the years 1939–43. Aside from an irregularity in the trend, probably arising from the small number of cases involved, the death rates from leukemia increased with corresponding increases in average rentals.

Other Etiological Factors

In 1938, Forkner (*1*) wrote that "in a minority of [human] cases some disease or incident can be found in the patient's life to which the leukemia is sequential in time, and to which, in some degree, it may be related, but in the majority of cases no such antecedent is demonstrable." Each year newly observed ante-

Figure 2. Average annual death rate for all forms of leukemia per million white population, according to age and sex, for urban and rural residents of the United States, 1944–48.



cedent events are reported, and the evidence, with regard to some, is mounting that they provide conditions "sufficient" to induce leukemia. Hueper (*11*) in his text on occupational tumors has provided the most exhaustive consideration of these factors.

Exposure to Radiation

Wynder (*12*), in a discussion of the practical aspects of cancer prevention, reviewed the evidence for the relationship between the development of leukemia and prior exposure to radiation or to chemicals suspected of having leukemogenic properties. His evaluation of present knowledge of these factors was that "no good evidence was at hand" except with respect to radiation and possibly with respect to benzol. Wynder's conclusion with regard to radiation was based, in part, on analyses by March and Ulrich of the mortality among radiologists from leukemia.

For a 20-year period ending in 1948, March (*13*) computed ratios of deaths from leukemia to all deaths for radiologists (4.68 percent) and for nonradiologist physicians (0.51 percent). He concluded that the risk of death from leukemia among radiologists was 9 or 10 times that of nonradiologist physicians. Dublin and Spiegelman (*14*) compared age-adjusted death rates from leukemia for male physicians (11.4 per 100,000) to the rate for the white male population (6.5) and found a ratio of 1.75. Later they found the number of deaths from leukemia among radiologists during 1938–42 was "several times the number expected on the basis of the mortality experience of all male physicians" (*15*).

Peller (*16*) cited age-standardized rates for mortality from cancer exclusive of leukemia and from leukemia for radiologists, all other physicians, and for all white American males of the same age. He concluded that the mortality from leukemia was 3.5 times greater for radiologists aged 35–74 than for other physicians, and 8.5 times that of all white males of similar age. These ratios are somewhat less than the estimates of March. It was his impression that part or all of the increase in the leukemia mortality took place at the expense of the total mortality from all cancer, including leukemia, though he was unable to confirm this from the data available.

The fact that all persons, with even more prolonged exposure to radiation or to chemicals, do not develop leukemia (for example, not all radiologists die of leukemia) suggests that for those who do not succumb, some condition or conditions "necessary" to leukemogenesis are not operative. It has been frequently suggested that presence or absence of a hereditary predisposition might explain some of the vagaries of the behavior of the disease in a human population, that is, that a "cancer diathesis" might be a necessary condition for leukemogenesis.

Genetic Predisposition

Videbaek (*17*) published in 1947 the results of a genealogical study in Denmark of the families of 209 leukemic probands selected from 310 leukemia patients on the basis of availability of sufficient family data. The study was controlled with the families of 200 nonleukemic persons. Leukemia was found to have been diagnosed in members of 17 of the 209 families of leukemic probands (8.1 percent), and in only 1 of the 200 families of controlled nonleukemics.

Videbaek discussed genetic mechanisms which are consistent with the production of familial aggregates of disease of this order and came to the conclusion that human leukemia seemed to be generally dependent on, among other conditions, a nonspecific hereditary pre-

disposition to cancer. He estimated that this predisposition is present in at least 20 percent of the population and is partly dependent on one or several genes which determine, to some degree, the localization of the cancer.

There was no attempt in this study of genealogies to define the "other conditions" on which the occurrence of leukemia might be dependent. And since familial aggregates of similar order have also been observed for diseases of both infectious and environmental etiology no conclusions can be drawn with reference to the relative importance of genetic factors in the production of human leukemia.

Summary

1. Variations in age, sex, race, and socioeconomic selection of leukemia are reviewed and data on urban-rural distribution of deaths from leukemia in the United States are presented.

2. The finding that death rates from leukemia at certain ages are significantly higher in urban than rural populations of the United States, while at other ages they are of the same order, appears to be inconsistent with a hypothesis that the higher crude rates in urban population can be accounted for by superior diagnostic services in cities.

3. From the published data reviewed there is no evidence that hereditary influences or exposure to leukemogenic agents are mutually exclusive in the etiology of human leukemia nor that they may not be considered jointly as coleukemogenic factors.

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Clues to Suicide

By EDWIN S. SHNEIDMAN, Ph.D.,
and NORMAN L. FARBEROW, Ph.D.

THE IMPORTANCE of the phenomenon of suicide is gauged by the fact that more than 20,000 people take their lives each year in the United States (*1*). Professional psychiatric, psychological, and social services might save many potentially suicidal persons if the danger is anticipated. In our continuing study of suicide at the Veterans Administration Neuropsychiatric Hospital in Los Angeles County, Calif. (*2–4*), we are attempting to discover a few of the danger signals.

A basic point of view implicit in our study is that we believe suicide to be motivated by sociologic, cultural, ecologic, psychological, and many other factors (*5–8*). Another basic point of view is our belief that meaningful studies of suicide can effectively use the scientific method of experimental control.

Our purpose at this time is to describe an experimental approach in the investigation of psychological factors in suicide and to report a few tentative results. Although our study is limited to the psychological aspects of suicide, it does not preclude other important aspects of the phenomenon studied by Cavan, Dublin and Bunzel, Durkheim (*5–7*), and others.

Dr. Shneidman is chief for research, Psychology Service, Veterans Administration Neuropsychiatric Hospital, Los Angeles, and research associate, University of Southern California. He is also associate executive editor, Journal of Projective Techniques, editor of "Thematic Test Analysis," published in 1951, and author of the "Make a Picture Story" test, mentioned herein. Dr. Farberow is clinical psychologist, Veterans Administration Mental Hygiene Clinic, Los Angeles, and instructor in the extension service of the University of California at Los Angeles.

In its original form this paper was presented at the annual meeting of the American Association for the Advancement of Science, Berkeley, Calif., December 28, 1954.

Three Types of Raw Materials

Our raw materials are psychiatric case histories, psychological test results, and suicide notes. We have attempted to obtain adequate control data for each category so that statistical comparisons might be made.

Case Histories

The names of adult male suicides were obtained from the weekly lists of all suicides in the Los Angeles County Coroner's Office for the period 1944–53. By checking the names of completed suicides with rosters of former patients of Veterans Administration neuropsychiatric hospitals in the county, we collected the psychiatric case histories of 32 adult male patients who, some time after discharge from the hospital, had killed themselves.

The case histories of the 32 suicides were then checked with the case histories of an equal number of control cases in each of 3 comparable categories of neuropsychiatric hospitalized males: a group of 32 males who had attempted

suicide, a group of 32 who had threatened suicide, and a group of 32 who had no suicidal tendencies. In the 4 groups selected, all 128 subjects were male, white, and most of them were from 20 to 40 years old although the ages ranged from 20 to 69.

We have analyzed the 128 case histories in terms of more than 100 different social, economic, cultural, and psychological categories, and have computed the statistical significance of the differences among the 4 groups. Samples of the categories used for analysis are: family history details, economic level, parents' age at the time of various events in the subject's life, educational and vocational achievements, marital status, and psychiatric diagnosis—an example of which is presented in the accompanying table.

Psychological Tests

For our second type of raw data, we collected test results on the Rorschach ink-blot technique, the Thematic Apperception Test, the Make a Picture Story test, and the Minnesota Multiphasic Personality Inventory, among others.

Diagnostic classifications of subjects in suicide study

Classifications	Completed suicide	Attempted suicide	Threatened suicide	Non-suicidal
Neurotic				
Reactive depression	5	7	6	0
Hysteria	1	1	1	1
Anxiety reaction	2	2	3	5
Phobic reaction	0	0	1	0
Obsessive-compulsive neurosis	0	0	1	0
Dissociative reaction	0	0	0	1
Neuropsychiatric mixed and/or undetermined reaction	0	2	2	1
Total	8	12	14	8
Psychotic				
Schizophrenia, simple	0	0	0	2
Schizophrenia, hebephrenic	0	1	0	0
Schizophrenia, paranoid	9	6	6	3
Schizophrenia, catatonic	1	0	0	1
Schizophrenia, unclassified	0	1	0	4
Schizophrenia, mixed	1	1	4	2
Manic-depressive psychosis, manic	1	0	0	0
Manic-depressive psychosis, depressed	2	0	2	0
Psychotic depression	0	1	0	0
Paranoid state	0	0	0	1
Involutional melancholia	1	0	0	0
Total	15	10	12	13
Organic				
Epilepsy, grand mal	0	0	0	0
Epilepsy, petit mal	0	0	0	1
Epilepsy, idiopath	1	1	0	0
Epilepsy, psychomotor equivalent	0	1	0	0
Traumatic encephalopathy	0	1	1	0
Paresis	0	0	0	1
Total	1	3	1	2
Miscellaneous				
Passive dependency	1	2	0	2
Emotional instability	0	2	1	1
Inadequate personality	0	1	0	1
Character disturbance	0	0	0	1
Psychopath	0	0	1	0
Alcoholism	7	1	3	4
Schizoid personality	0	1	0	0
Total	8	7	5	9
Grand total	32	32	32	32

In collecting these data we followed much the same precedure used for obtaining the case histories. The lists of suicides in Los Angeles County were checked against the hospital rosters. Then the previously administered psychological tests on individuals who had subsequently committed suicide were found. Psychological tests on comparable groups of individuals who had attempted suicide, threatened suicide, or who were nonsuicidal were obtained next, and the test results among the four groups were compared.

However, only the test results for 96 of the 128 subjects—the nonsuicidal subjects and those who attempted or threatened suicide—have been analyzed so far. Data for those persons who had been tested and who subsequently committed suicide have not yet been collected in numbers sufficiently large to be subjected to statistical analysis.

Suicide Notes

For our third set of raw materials, we collected 721 genuine suicide notes with the cooperation of the Los Angeles County Coroner's Office. The notes were written during the period 1944 through 1953. Some were written by men, some by women, others by children. The writers were as young as 13 and as old as 96.

There are practical, as well as theoretical, difficulties in obtaining control data to match with genuine suicide notes. A practical difficulty is that notes written by people who have threatened or attempted suicide are hard to obtain inasmuch as they are usually destroyed. To obtain control data, we asked certain individuals, carefully matched with the genuine suicide-note writers, to write the simulated suicide note they would leave if they were going to take their own lives.

The names of the people we asked to participate were obtained from such community sources as labor unions and fraternal groups. In recognition of the moral and ethical overtones associated with suicide, we employed preliminary screening tests, interviews, and other safeguards in order to screen out anyone who might be upset by writing a fictitious suicide note.

Our last step was to analyze the genuine and pseudosuicidal notes and to relate the statistically significant results to the major psychiatric, psychoanalytic, and psychological hypotheses about suicide.

Results of Research

The following findings come from the research in process and are tentative in nature.

Case History Comparisons

From our studies of the four sets of psychiatric case histories (*2*), we concluded:

1. It is practically impossible to distinguish a potentially suicidal person from the details of his case history alone, however stressful or traumatic it has been.

2. Seventy-five percent of the subjects who committed suicide had a history of having previously threatened or attempted suicide, although a suicide threat or gesture is not necessarily the mark of a potential suicide.

3. Almost half of the individuals who committed suicide after leaving the hospital did so within 90 days after having been discharged.

As to the first finding, there were few differences in the case history details among the four groups. For example, as many people in one group as in another were only children, came from broken homes, had a history of suicide in the family, and so forth.

From all the comparisons made of the 4 groups we found that only a diagnosis (see table) of reactive depression or paranoid schizophrenia differentiated the 3 suicidal groups (completed, threatened, and attempted suicide) from the nonsuicidal group. Only a history of mental hospitalization among members of the family distinguished the completed suicide group from the other 3 groups. All other comparisons yielded negative results.

Although it is true that not all people who have attempted or threatened suicide go on to commit suicide, the contrary fact—our second finding—is even more striking; that is, there is a large percentage of suicides, specifically 75 percent in our study, who have a history of having threatened or attempted suicide. This fact would seem to indicate that suicidal gestures (attempts or threats) may be considered as danger signals and must be taken seriously.

The results of this study do not permit us to state whether the same percentage would apply in a general population. Nevertheless, the finding does suggest that suicidal threats and attempts are a danger signal in the type of suicidal population found in a neuropsychiatric hospital or sanatorium.

Clinical observations in the psychiatric literature corroborate the finding that almost half of the individuals who did commit suicide after leaving the hospital did so within 90 days after discharge. Thus, it appears that even though persons of observed suicidal tendencies are judged to have improved sufficiently to be ready to function in the community again, they are in a dangerous period. It is not possible to state what might be the result of keeping such patients in the hospital another 90 days without further detailed, controlled investigation.

This third finding has implications for timing discharge from treatment and for continuing vigilance in behalf of these emotionally disturbed individuals: It would seem that if a person has been making suicidal attempts or threats, his physician and relatives must be especially cautious for at least 3 months after he appears to be improving and after he seems to be on his way to recovery.

Psychological Test Comparisons

Our study (*3*) of the psychological tests for those who attempted suicide, threatened suicide, or who were nonsuicidal resulted in the interesting finding that there are differences among individuals heretofore loosely classified as "suicidal." The people who threatened suicide seemed to be more emotionally disturbed than the people who had attempted the act.

There were some differences between people who attempt suicide and threaten suicide. Specifically, individuals who have threatened suicide show more guilt, aggression, irritability, and agitation—in a word, more disturbance—than do individuals who have attempted suicide. Those who have attempted suicide are more like the nonsuicidal mental hospital patients, except perhaps more withdrawn. It is almost as though the attempt itself had operated in an abreactive and therapeutic manner and had lessened the immediate seriousness of the personality disturbance. This temporary relief, however, does not mean the emotional state preceding suicide will not return.

Genuine and Simulated Notes

From the preliminary comparisons of genuine and simulated suicide notes (*4*), we are presenting only the results of our application of the Discomfort-Relief Quotient, a technique developed by Mowrer (*9*).

Mowrer's technique is used to measure the relative amounts of discomfort thought units, relief thought units, and neutral thought units contained in case history materials or in statements made during psychotherapy sessions. The thought unit is a discrete idea, regardless of number of words. The Discomfort-Relief Quotient was deemed to be applicable to the analysis of genuine and simulated suicide notes for indications of the current emotional and ideational state. Thirty-three male, white, Protestant, married, native-born, genuine suicide-note writers were matched man for man, by age and occupation, with 33 nonsuicidal, simulated-note writers.

The total number of thought units was significantly higher in the 33 real notes than in the fictitious notes, indicating that the genuine-note writers apparently feel the need to say more in this last communication.

With respect to the "discomfort" statements, or the statements of guilt, blame, tension, aggression, and the like, we found no statistically significant difference between the prorated number of discomfort units expressed by the genuine suicide-note writers and those expressed by the simulated-note writers.

As for the number of "relief" statements, or statements which were pleasant, warm, loving, and which denoted relief from tension, we found no quantitative difference between the genuine notes and the simulated notes.

It was in regard to the "neutral" statements, the statements free of expressions either of tension or of release from tension, that the notes revealed the greatest significant difference. The genuine suicide notes contained much the higher percentage of neutral thought units. On inspection, we found them to be mostly statements giving instructions and admonitions and sometimes listing things to do.

What might our findings indicate about suicide-note writers?

We interpreted the higher percentage of neutral thoughts expressed by the genuine-note writers to indicate two important, although quite contradictory, feelings on their part and, in addition, to reflect a basic difference in the attitudes of the two groups of writers.

The genuine-note writer has apparently accepted and incorporated the idea that within a short time he will not be alive. He therefore instructs and admonishes in relation to the many details of continued living which he will not be able to pursue himself.

The fictitious-note writer, although he can apparently fantasy the "affect" of suicide, inasmuch as the number of relief statements and discomfort statements are proportionately the same, does not take that additional step of converting his fantasy into the "reality" of imminent absence.

In other words, only the genuine suicide-note writer can fantasy his really being gone. At the same time, there is a distinct contradiction between his decision to die and his listing of things to do and his plans for the future. It is as though he were exercising power and command in these directions, as if he somehow were making sure his plans would be carried out. It is a kind of unrealistic feeling of omnipotence and omnipresence on the part of the suicidal individual which may reflect in part some of the confused, illogical, and paradoxical motivations in the entire act.

We noted that the discomfort statements in the simulated suicide notes were only mildly negative but that similar statements in the genuine notes were characterized by deeper and more intense feelings of hatred, vengeance, demand, and self-blame. As used at this time, however, the discomfort measure does not reflect these differences.

Some Words of Caution

In addition to the fact that our project deals only with some of the psychological aspects of suicide, as revealed in case histories, psychological tests, and suicide notes, some other limitations of the study should also be made explicit.

The data we have analyzed so far are restricted to a specific period (1944 to 1953) and to a specific area (southern California) and, therefore, cannot be representative of all times and all locations.

We wish to point out also that, although the 721 suicide notes in the study represent almost 100 percent of the suicide notes written in Los Angeles County during the 10-year period 1944–53, only about 15 percent of the suicides in the county have left notes. Thus, the conclusions about the psychology of suicide from this source may possibly contain some as yet undisclosed sampling biases.

Our clues about suicide are to be taken only as an interim report of tentative findings from a continuing study. We hope, within the next few years, to report more definite information about the psychological nature of suicide from which a clearer theoretical understanding of its motivations can be obtained and, perhaps, even some clues as to how its prevention and control can be evolved.

Summary and Conclusions

The following five points are offered as a summary of the findings and implications of this interim report:

1. Three-fourths of our subjects who committed suicide had previously threatened or attempted to take their own lives. This means that suicidal behavior, whether attempted or threatened, must be taken seriously, inasmuch as the next suicidal "gesture" may be the final one.

2. Almost half of the individuals who committed suicide did so within 3 months of having passed an emotional crisis and after they seemed to be on the way to recovery. This means that physicians and relatives must be especially cautious and watchful for at least 90 days after a person who has been suicidal appears to be improving.

3. On the basis of comparisons among psychological tests, it appears that the person who threatens suicide seems to be more emotionally disturbed than the person who attempts suicide, but both must be taken seriously and watched carefully at least for 3 months.

4. The comparison of genuine suicide notes with simulated suicide notes indicates that the

person about to take his own life includes orders and admonitions as though he had reached a final decision in solving his problems and had accepted the fact that he will soon no longer be around.

5. Calling upon professional psychiatric, psychological, and social service specialists for the treatment of a potentially suicidal person may mean the difference between life and death.

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Special Assistant for Medical Affairs

Dr. Lowell T. Coggeshall, nominated by President Eisenhower to be special assistant for health and medical affairs to the Secretary of Health, Education, and Welfare, has been dean of the University of Chicago division of biological sciences, which includes the university medical school, since 1947. In this position, he directed one of the country's largest biological and medical research centers.

He succeeds Dr. Chester S. Keefer of Boston, Mass., who resigned August 1, 1955. Until July 1, 1955, Dr. Coggeshall was also chairman of the Committee on Medical Sciences of the Department of Defense, and at present he is chairman of the Medical and Scientific Committee of the American Cancer Society.

An authority in the field of tropical medicine, Dr. Coggeshall, then a captain in the Navy, was assigned by the Army Air Force during World War II to the Pan American World Airways in Africa, where he was responsible for establishing medical services along air routes through Africa and the Far East. Later, he was named special medical consultant to the Secretary of War, and during his tenure in that post was in charge of the Klamath, Oreg., tropical disease hospital for Navy and Marine personnel.

Dr. Coggeshall, born in Saratoga, N. Y., in 1901, received his medical degree in 1928 at the University of Indiana, where he also was awarded the degree of doctor of laws in 1948. From 1935 to 1940, he was a staff member for research in tropical diseases, international health division, of the Rockefeller Foundation. He was professor of preventive medicine of the School of Public Health, University of Michigan, from 1940 to 1941, and was chairman of the department of tropical medicine, University of Michigan Medical School, from 1942 to 1944. He then returned to the University of Chicago as head of the department of medicine.

The American Heart Association and Federal, State, and local health organizations work together to further research, community service, and education in the cardiovascular diseases.

Cardiovascular Diseases and Public Health

By JOHN W. FERREE, M.D., M.P.H.

- One out of every sixteen persons in the United States has some form of cardiovascular disease.
- One out of every two deaths in this country is from a disease of the heart or blood vessels.
- Approximately 176 million workdays are lost yearly because of heart disease.
- Cardiovascular diseases accounted for the major or secondary impairment in more than 42 percent of those receiving aid under the Bureau of Public Assistance of the Social Security Administration program for the permanently and totally disabled, as shown in a cross-section survey.
- Cardiovascular diseases are long-term diseases; hypertension, for example, has an average course of 20 years.
- In the general population, 3 percent of untreated streptococcal infections are followed by rheumatic fever; among those who have had rheumatic fever, the figure can be as high as 50 percent.
- A recent study of the caseload of the Instructive Visiting Nurse Association in Baltimore indicated that 46 percent of the nonmaternity cases had some disease of the heart or circulatory system as the principal diagnosis.

Dr. Ferree is director of community services and education, American Heart Association, New York, N. Y. He was formerly State health commissioner of Indiana.

All these are persuasive—if coldly statistical—reasons for firmly placing the cardiovascular diseases in the public health domain. The American Heart Association has long recognized the public health implications of heart disease, and the concept of community responsibility in prevention, diagnosis, treatment, and education is basic to its philosophy.

The association regards the person with heart disease as a person with social, economic, and personal problems which bear not only on himself and his family but on the community as well. It follows that these problems lend themselves in great measure to successful attack by organized community effort, long accepted as a criterion for public health action. These cardiovascular disease problems, then, are definitely a public health responsibility.

History

Community action to help the cardiovascular disease patient has from the start been one of the primary concerns of the American Heart Association.

The first organized effort to collect and apply information on heart disease was made by a group of New York physicians whose interest was sparked by pioneer cardiac rehabilitation work being done at Bellevue Hospital. In 1916, they formed the "ancestor" of the AHA, the Association for the Prevention and Relief of Heart Disease. Dr. Haven Emerson, then commissioner of health in New York, was a leading spirit of the movement.

One of the association's first actions was to encourage formation of cardiac clinics similar to the one at Bellevue. Soon 20 clinics were functioning in hospitals and outpatient departments.

Aside from clinic work, the young organization busied itself with fulfilling its other goals and purposes:

"To gather data from wide sources and arrange for its practical application, in education, occupation, and social welfare; to study and develop occupations and vocational guidance for cardiacs; to take a formative interest in workmen's compensation insurance and similar problems affecting cardiac patients; to work constantly for the prevention of heart disease through the dissemination of information and the application of preventive means (as in increased facilities for postrheumatic throat and dental treatments); to organize cardiac convalescence to provide larger opportunities in existing institutions, especially for youth; to assist in coordinating the various efforts in this field as made by health departments, schools, cardiac classes, special investigators, the Trade School for Cardiacs, etc.; and to encourage the formation of branch associations."

By the early 1920's, physicians throughout the country had become interested in the association's work. Accordingly, the New York group invited about 100 physicians to a meeting in St. Louis on May 24, 1922, to plan for a national organization. Two years later, on May 20, 1924, the American Heart Association was formally incorporated under the laws of New York State.

The St. Louis meeting defined the objectives of the projected national organization as follows:

"The function of such an association would be to coordinate all activities bearing on the heart problem, to develop new lines of research, to collect and distribute information, to further public health and industrial education, and to develop a sound public opinion as to the true meaning and seriousness of the problem."

Not all of these objectives could be carried out immediately. For more than two decades, the association performed important professional functions. It published a scientific journal, held an annual 2-day scientific meeting, and established standards in such technical matters as clinical electrocardiography and blood pressure readings.

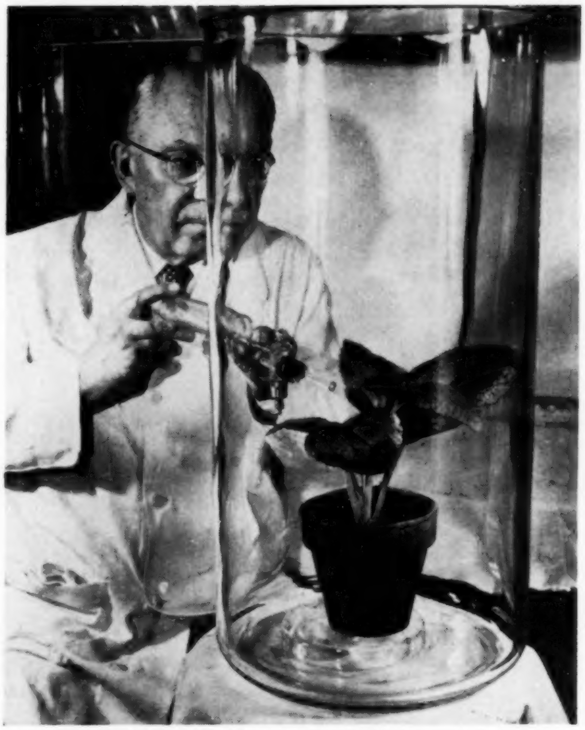
Of particular significance were the early and continuing achievements in standardizing nomenclature and criteria for diagnosis of cardiovascular diseases. The first work in this area was done in 1916; it has been carried on by the New York Heart Association, which publishes "Nomenclature and Criteria for Diagnosis of Diseases of the Heart and Blood Vessels." With uniform standards, we were able to learn more precisely the nature and size of the problem we were dealing with.

As more knowledge became ours, two basic facts that were responsible for the association's ultimate change of course began to stand out: (*a*) that the heart and blood vessel diseases constituted a problem of far greater magnitude than had been supposed, and (*b*) that much could be done to control these diseases, that the old fatalism could well be replaced by hope and optimism.

From these two premises, it was clear that the public health responsibilities which the association had set out for itself had become even more pressing. Yet the association, a small group of physicians and scientists, was not organized to cope with the multiple problems which cardiovascular disease poses for the individual, his family, and the community, nor was it equipped to get its message of hope to the people.

Moreover, a full-fledged program of research was imperative if the war on heart disease was to move ahead. By the 1940's, research had already contributed to the feeling of optimism regarding heart diseases—cardiac surgery, penicillin and sulfa drugs for the prevention of rheumatic fever and subacute bacterial endocarditis—and it could be counted on to produce other advances.

The time had come for a broad community approach to the cardiovascular diseases. Addition of the lay public to the ranks of those already fighting heart disease was the logical first step. Citizen support was needed to finance research, for the channeling of new and existing information to the public as well as to professional groups, and the development of community services for the patient with heart



Foxglove plant "breathing in" radioactive carbon dioxide syringed into surrounding bell jar. Radioactive digitalis will be prepared from the dried leaves for use in tracer studies.

disease. And, certainly as important, informed laymen were needed to organize and coordinate community programs all over America.

In 1948 the American Heart Association was expanded into a voluntary health agency, the only national voluntary health agency devoted exclusively to combating diseases of the heart and circulation. Laymen and professional persons not previously eligible were admitted to membership and to places on the association's governing bodies for the first time.

At present the AHA and its affiliates have a voting membership of about 25,000, almost evenly divided between physicians and laymen. There are now 56 direct affiliates and more than 350 local chapters, which are largely autonomous in developing programs to meet their own community needs. The national headquarters in New York administers the national phases of the program, maintains a clearinghouse of ideas and suggestions for the work of State and local associations and committees, and provides educational and program guidance materials and services for them.

The program activities of the American Heart Association are financed primarily by public contributions made during the annual February Heart Fund campaign. At least half of the funds received by the national office are spent to support research, which has top priority in the program as the single most important factor by which we hope to conquer or control the heart diseases.

But results of research do not automatically become full-fledged community programs for helping people with cardiovascular disease. And the encouraging news of scientific progress does not announce itself to those who should hear it. To reach them, an educational program is needed.

Guiding the association's triple program of research, community service, and education are three councils, each directly responsible to the board of directors of the association. They are the Scientific Council, the Council on Rheumatic Fever and Congenital Heart Disease, and the Council on Community Service and Education. The councils are subdivided into committees made up of specialists in their particular fields, who, through their combined experience, are able to give advice and guidance on heart programs.

"Tracer" digitalis enables researchers to follow the drug and to study its action after it enters body tissue.

Research

Since 1948, a total of approximately $13 million has been allocated by the American Heart Association, its affiliates, and their chapters for research support. Affiliates and chapters which make research awards in their own areas do so in addition to their contribution to the national research fund.

The association offers research support at three levels: research fellowships and established and career investigatorships.

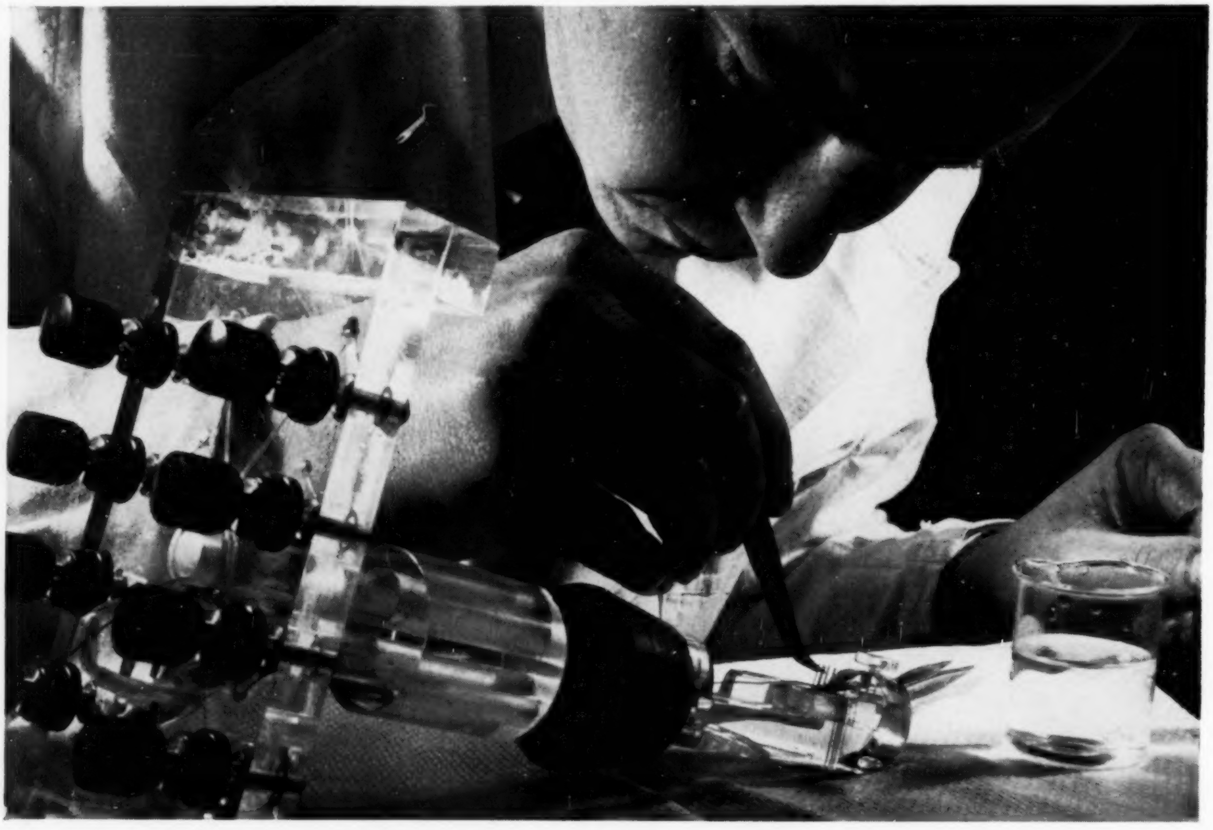
Research fellowships are granted to young men at the outset of their careers, for a 1- or 2-year term, to enable them to train as investigators under experienced supervision.

Established investigatorships provide support for a 5-year period to scientists who have demonstrated their capacity in research and have developed to the point where they are independent investigators.

Career investigatorships, now held by three men, provide an annual stipend throughout the productive lives of carefully selected scientists of proved and outstanding investigative capacity and genius.

In addition to these three forms of research support, grants-in-aid are awarded to provide the tools of research—technical aid, equipment, and supplies—to experienced investigators working on a specified program of research.

Epidemiological research—studies of diseases of the heart and blood vessels in terms of their incidence and prevalence among population groups with varying characteristics—is beginning to take its place beside basic or experimental research, for which it supplies the clues. For example, the association of overweight and mortality from heart disease was one of the leads that gave impetus to experimental studies of cholesterol and lipoproteins. Similarly,



Investigator placing heart muscle between the electrodes of a plastic holder, which will be immersed in vessel of warm salt solution (right) and then stimulated to contract rhythmically. As different drugs are added to the solution, their effect on the muscle's action can be observed in detail by instruments which record the force of its contraction and the electrical impulses generated by it . . . to gain a better understanding of how the heart muscle works and to improve methods for treating it when its pumping action is impaired.

In the "pleated balloon" test, which measures vital lung capacity, patient raises top panel as high as possible. This is part of the Cleveland Area Heart Society's cardiac work classification clinic procedure to help measure the patient's work capacity.

epidemiological evidence established the relationship between streptococcal infections and rheumatic fever.

Community Service

Although the research programs can be actively participated in by only a few hundred individuals, the AHA's community service program is entered into by thousands of men and women, physicians and laymen alike.

Because they are planned and carried out locally, heart association services vary from community to community. The American Heart Association sets general policies and gives guidance, and the State or regional affiliate gives its support and help, but the actual work is in the hands of the heart association in the community.

A local heart association does not try to solve all of the community's heart disease problems singlehandedly. "Heart disease will not be conquered by the lone wolf approach" has been echoing in heart association ears ever since it was first declared at the First National Conference on Cardiovascular Diseases, held in Washington in 1950 and sponsored jointly by the American Heart Association and the National Heart Institute, Public Health Service.

In tailoring its programs to the community, a local heart association may work at different times with parent-teacher associations, social work and welfare agencies, labor unions, business and church groups, and other voluntary and official health agencies. It should at all times maintain a close working relationship with the local health department.

A typical community service program might include clinics for patients with cardiovascular disease, rheumatic fever prophylaxis, rehabilitation services and work evaluation units offering to cardiac patients and housewives simpler work methods, vocational counseling, nutritional guidance for patients with heart disease, and home care.

Clinics

The clinic has long been an important concern of heart associations and frequently serves as a focal point for the entire community program. Although heart associations do not actually operate clinics, they help insure the best possible services for the patient by granting certification to local clinics that meet the standards established by a national AHA committee, as outlined in the AHA booklet, Recommended Standards for Cardiovascular Clinics. In addition, a heart association often buys equipment for a clinic or contributes, on a demonstration basis, toward the salary of a medical social worker, a public health nurse, or other professional worker.

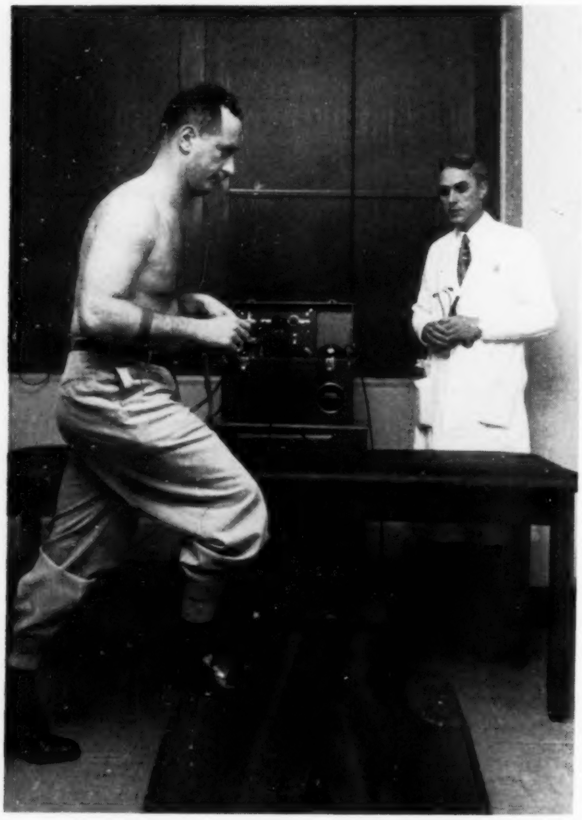
Rheumatic Fever Programs

Most heart associations are developing community programs for the prevention, control, and treatment of rheumatic fever. Rheumatic fever committees of heart associations work closely with physicians to encourage the widest use of antibiotic preventive techniques presently available. They support community diagnostic services, cooperate with school health authorities to develop screening procedures, and in some cases sponsor traveling clinics for isolated rural areas. Several such traveling clinics have been organized in cooperation with the State or local health department.

Rehabilitation Program

The cardiac rehabilitation program helps patients with cardiovascular disease to remain independent, self-supporting members of society, thus bringing them psychological as well as eco-

nomic benefits. A pioneering development in this area is the work classification unit, often attached to a cardiac clinic. Each unit provides a counseling service to which physicians and industry may refer patients with employment problems stemming from cardiovascular disease. Here the patient's work capacity is assessed by a team representing several professional disciplines, as a basis for selective placement in a job where he can perform fully without overtaxing his physical reserve.



Physician watches the "master two-step exercise test" in the New York Heart Association's work classification unit. Patient climbs the steps, turns around, and goes down 20 times while "hooked up" to the electrocardiograph. Immediately after the exercise he lies down and receives an electrocardiograph examination.

Together with other services, such as the sheltered workshop and vocational guidance, the work classification unit does much to aid the physician in the practical management of the patient. At the same time it helps to break down the barriers that still keep many capable patients with heart disease from productive employment.

In the "Heart of the Home" program, rehabilitation principles have been adapted to the needs of the housewife with cardiovascular disease. Housewives are taught how to simplify their work habits and conserve their strength. Special courses are given by heart associations for cardiac homemakers and for those who frequently come in contact with them—nurses, occupational therapists, home visitors.

Nutrition Program

The problems of overweight and diet have occupied the attention of many local heart associations. A number of heart associations, working with their health departments, have organized weight-control groups, and several have given low-sodium-diet cooking classes.

On the national level, the American Heart Association, in cooperation with the Council on Foods and Nutrition of the American Medical Association and the Food and Nutrition Board of the National Research Council, developed recommendations for more precise labeling of the sodium content of special dietary food products, which were incorporated in 1954 in the official regulations by the Food and Drug Administration. Although neither the American Heart Association nor its branches approve or disapprove of specific dietary food products, local heart associations should be able to refer patients to sources of dietetic foods in the community.

Chronic Illness

Another area of community service concerns chronic illness. Home care programs are being explored now as a way for heart associations to cooperate with other community groups in such projects.

In whatever ways a heart association carries out its program, the underlying philosophy is one expressed by Dr. Martin Cherkasky, chairman of the Council on Community Service and Education: "To help those who suffer from heart disease reap the benefits of ever-expanding knowledge, to help them meet the practical problems which illness creates for most individuals, to help them learn the message of hope which the achievements of recent years fully

Work conference sponsored by the Washington State Heart Association in cooperation with schools of nursing and the State health department. Special training courses, workshops, and work conferences such as this improve nursing care for cardiac patients.

justify—these are the goals of the association's program of community service and education."

Education

The educational efforts of the American Heart Association fall into two main categories—programs directed at physicians and other professional groups (nurses, dietitians, teachers, clergymen) and programs directed at the general public and special lay groups (parents, patients, workers).

The AHA education program for physicians is designed to make available the mass of new and existing knowledge in the field of cardiovascular disease. The annual scientific sessions are probably the most comprehensive presentation of developments in cardiology. In addition, affiliated and local heart associations schedule scientific meetings, forums, postgraduate courses, and other events for the medical profession in their areas, often in cooperation with the local health department and medical societies.

Publications for physicians include two scientific journals, *Circulation*, a monthly, and *Circulation Research*, a bimonthly. These have become outstanding media for reports on clinical and basic science subjects. In addition, the bulletin, Modern Concepts of Cardiovascular Disease, reviews a specific cardiovascular subject each month.

Handbooks, manuals, and other materials are also issued to help physicians. These include recommendations for blood pressure determination and for examination of the heart; the previously mentioned book on nomenclature and criteria (prepared by the New York Heart

Association), standards for electrocardiography, and recommendations on cardiac catheterization and angiocardiography.

Audiovisual tools for medical teaching and meetings are a recent development. They include heart models, films, slides, tape recordings of normal and abnormal heart sounds, a three-dimensional visual kit (Cardio-Views), and an audiovisual kit (Cardiac Clinic), which combines slides and a recorded medical discussion.

Most heart associations plan educational meetings, forums, and workshops for other professional groups. Frequently, as in workshops in cardiovascular nursing, these are held in cooperation with the health department and other community agencies and organizations.

Several heart associations have held pastoral counseling meetings for clergymen; and many have brought together groups of teachers, social and vocational workers, occupational and physical therapists, and dietitians and nutritionists to discuss the needs of the cardiac in relation to their particular profession. A number of heart associations conduct special industrial education programs to tell both workers and employers the "cardiac can work" story.

The public education program of the association, conducted on the national and local levels, has been a major factor in creating a climate of optimism and confidence that grows out of a rational understanding of heart disease. Booklets and pamphlets, films, exhibits, and meetings are planned to stress accurate information without exaggeration or distortion, to correct misconceptions, to substitute encouragement and realistic hope for the fear and fatalism of the past, to emphasize the scope of the cardiovascular problem and the belief that heart disease can ultimately be controlled through research, and to urge prompt and proper treatment of heart and circulatory disorders.

The national office provides the general reader with a continuing progress report on advances in the heart program through its quarterly periodical, *The American Heart*, and through its press information services.

Both the national office and its local associations maintain inquiry services to answer specific questions from individuals and professional persons in need of information and advice. In addition, most local heart associations maintain a speakers bureau to provide well-informed public speakers, usually physicians, to interested groups.

Association-Health Department Relation

At about the same time the American Heart Association became a voluntary health agency, the National Heart Institute came into being as one of the National Institutes of Health. In 1950, lay and professional leaders of the two groups met together in Washington for the First National Conference on Cardiovascular Diseases "to determine what we know about cardiovascular disease and how we can apply this knowledge to prevent and cure it." What came out of the conference became the basis for much of the work that both groups have since done.

This past year, the National Heart Institute and the American Heart Association undertook an educational campaign against rheumatic fever, jointly preparing materials for distribution to health departments and heart associations. The basis of the campaign is a 4-page statement by the AHA Council on Rheumatic Fever and Congenital Heart Disease, entitled "Prevention of Rheumatic Fever and Bacterial Endocarditis Through Control of Streptococcal Infections." This was issued first in 1953 and revised in 1955. Other educational materials in the "Stop Rheumatic Fever" unit (*1*) include a black-and-white film, discussion guide, and leaflets.

The Manual on Administration and Organization for Affiliates of the American Heart Association clearly spells out the heart association-health department relationship:

"Official agencies are legally charged with the responsibility of protecting the public's health. Heart associations have voluntarily assumed a share in this responsibility and should work closely with official agencies toward their common goal.

"Any programs undertaken by a heart association should be brought to the attention of the health department. A number of health departments have developed extensive programs for the control of heart disease. Because these programs, like those of heart associations,

are financed by public funds, both agencies are responsible for seeing that the funds are not wasted through overlapping or competitive programs.

"A practical arrangement is to have an officer or board member of the heart association on the health department's advisory committee and to have a member of the board or staff of the health department on the board of the heart association.

"This does not mean that every enterprise must be a joint one; each agency maintains its identity and individuality because each has something different to offer. The broad community representation in the heart association makes it possible for the association to furnish leadership, to act as a pioneer in program development, and to stimulate the official agency to make the best possible use of its resources of money and personnel. Very often the two agencies working together can accomplish more than they could achieve separately."

How does this statement work in practice?

In New York staff members of the statewide heart affiliate spend 2 or 3 days each year in meetings with representatives of the State health department, welfare department, and division of vocational rehabilitation. At these meetings, government and heart association personnel exchange ideas and information on rehabilitation, public health nursing and education, school health, chronic disease, and other areas of mutual concern.

Not only do the groups find they understand each other better, but often new programs develop as a result of these sessions. From the liaison in New York, the heart affiliate undertook a demonstration project in rehabilitation at the suggestion of the State health department. The health department will take over the project—paying the salary of a rehabilitation counselor on the health department team—at the end of the 3-year demonstration period.

Sometimes the financial responsibility for projects is reversed, as in the cardiac work classification unit of the Heart Association of Southeastern Pennsylvania. The Pennsylvania Department of Health finances the unit, which provides for service to individuals whose employment problems are caused by cardiovascular disease.

One of the reasons heart associations find it so important to work with their local health departments, medical societies, and other groups stems from the AHA policy of spending money not for individual care but for community programs in cooperation with others, for demonstration projects where needed facilities do not exist, or for salaries and equipment to supplement the services of some other agency.

Behind this policy is the belief that the association's purposes will not be best served by giving financial aid to individuals to cover the costs of medical or nursing care, hospital bills, or drugs. Tremendous sums, far greater than those available to the association, would be necessary to meet such requirements on a fair and comprehensive basis. Moreover, diverting the association's limited funds to comparatively few individual patients would undermine its ability to carry out the program it has evolved to benefit all heart patients and to reduce cardiovascular disease as a threat to the Nation's health.

Health Department Problems

The American Heart Association recognizes the difficulties faced by health departments in meeting the problems of cardiovascular diseases. Shortage of funds, insufficient personnel, hands full just keeping up the traditional health department functions—these are familiar conditions. Yet, as the communicable diseases fade as a major health problem and the chronic illnesses take their place, changes will be appropriate and possible.

A recent study made in Buffalo, N. Y., reveals that crowding, water supply, and sewage disposal have little bearing on four of the most frequent causes of death—heart disease, cancer, stroke, and diabetes (*2*). Certainly this is not to say that health departments should lessen their vigilance on the old problems. They will still be with us. And, as the Buffalo study also shows, deaths from infective and parasitic diseases are related to housing, water, and sanitation. But in time, control of these will be left-hand functions of the health department. As the chronic illnesses become more pressing problems, the emphasis will shift.

Until public awareness and financial re-

sources and sufficient personnel make the shift possible, what can a health department do so far as cardiovascular diseases go?

A health department, with little or no extra expenditure of time, money, or energy, can accomplish much simply by becoming heart conscious—being aware of the entire cardiovascular problem and letting this awareness pervade thinking and planning in all service and education programs:

Films taken in mass X-ray surveys can be read for possible heart disease and suspected cases followed up for diagnosis and treatment.

In prenatal clinics, special attention can be paid to pregnant women who have congenital or acquired heart disease.

Programs to control communicable diseases can include control of streptococcal infections.

Laboratory facilities can be used for blood sedimentation rates and antistreptolysin-O titers in suspected rheumatic fever and throat cultures in suspected streptococcal infection; laboratory technicians can be trained in prothrombin-time determination.

Nursing and convalescent homes can be inspected from the point of view of nutritional requirements and physical limitations of cardiovascular patients.

In nutrition programs, emphasis can be placed on counseling as regards various nutritional needs, such as the low-sodium diet for hypertension and congestive heart failure, and on problems of overweight.

In school health surveys, children with congenital or rheumatic heart defects can be discovered. Through followup services they can obtain the care and management possible through a greatly expanded knowledge in the two fields. It is here that the Crippled Children's Program has so much to offer.

Public health nurses can be instructed in the nursing care of cardiac patients.

A clearer picture of the cardiovascular problem can be obtained through careful recordkeeping.

In all health education programs, cardiovascular disease can be treated to dispel fear and replace it with a reasonable, more objective viewpoint. Teachers and parents can be informed about the relationship of streptococcal infections to rheumatic fever.

All these are things which health departments can do within their existing framework. A number of health departments, of course, are engaged in major programs related to cardiovascular disease.

The cardiovascular disease studies being conducted in Massachusetts, California, and New York State, among others, are calculated to give us the kinds of information that will more clearly define health department and heart association roles in prevention and control of cardiovascular diseases through organized community effort.

In these heart disease control programs, "prevention" is the key word. "Characteristically," writes Lester Breslow, chief of California's bureau of chronic diseases, "the public health approach to problems stresses prevention. As applied to heart disease and other chronic diseases, prevention includes measures which avert the occurrence of disease (primary prevention) and those which halt or retard the progression of disease into disability or premature death (secondary prevention)."

However much a health department is able to do now, and does do, it can be sure of having the help and support of its neighboring heart association. Heart association and health department alike are both working toward the prevention, in its broadest sense, of cardiovascular disease.

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The Epidemic Climate

By WINSTON H. PRICE, Ph.D.

IN THE 16th century, Fracastoro formulated the idea that communicable diseases were caused by "living agents," a thought that occurred to earlier minds but, except for the scabies mite, without supporting evidence that survived to modern times. Later investigators, such as Snow, Henle, Panum, Budd, Holmes, Semmelweis, and Hirsch, inferred the probable existence of such agents strictly by epidemiological methods. However, it was only after invention of the achromatic microscope that Pasteur, Koch, and their followers, using Henle's principles, demonstrated that microorganisms are the primary cause of certain diseases. This important work put on a firm scientific foundation man's understanding of the pathogenesis of infectious disease.

Since that time many other etiological agents (helminths, protozoans, fungi, bacteria, rickettsiae, and viruses) have been identified with diseases of both man and animals. Principal interest has focused upon the differential disease diagnosis and pathogenesis and the treatment of the patient. In comparison, relatively little attention has been paid to the biological survival mechanisms and mode of transmission of infective agents in a community, particularly during the endemic prevalence or during the interepidemic period. There has also been relatively little investigation of the factors that determine the fluctuations in incidence and distribution of communicable diseases or of those fundamentals that are of importance in determining whether an infection regresses spontaneously or evolves into an overt disease. There is evidence that such factors as climate and season and the nutritional state and hereditary constitution of the host are factors in the natural history of microparasites, but there is little experimental data to indicate just how these determinants influence the spread and survival of the infective agents.

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It was recognized early by such investigators as Koch, Pasteur, and Pettenkofer that, while specific agents caused specific illnesses, many other factors were also important in determining whether an individual harboring the infectious agent became diseased. Later workers have expressed similar views—the most recent, Burnet (*1*) and Dubos (*2*). However, although there has been much speculation, science has yet to define the circumstances which determine why in certain infections many individuals become infected but few become diseased.

The importance of the biological approach to epidemiology was fully appreciated by Frost (*3*). In 1934 Theobald Smith, in his Vanuxem lectures on parasitism and disease delivered at Princeton University, formulated concepts which were fundamental to the explanation of these phenomena.

Hamer (*4*), Soper (*5*), Hedrich (*6*), McKendrick (*7*), Wilson and Burke (*8*) and Reed of Johns Hopkins University tried to rationalize the occurrence of epidemics by the use of sta-

tistical formulas. Given the number of cases of measles, the number of susceptibles, the total population, and assuming an arbitrary value for contact rates in one time period of 14 days, the number of new cases which will arise in the successive time periods of the same length can be calculated. Epidemic theory of this sort yielded some interesting concepts about the spread of contagious disease. However, for infectious diseases, the practical usefulness of this statistical theory is quite limited (*9*). It is impossible with these criteria to take into account and to evaluate the many factors influencing the propagation of an infectious agent in nature.

Another approach to the study of the epidemiology of communicable diseases is the mass serologic survey for which Paul has coined the term "serologic epidemiology." This method has proved of value in such diseases as poliomyelitis and yellow fever. However, in recent years it has become obvious that in certain communicable diseases, such as those caused by certain arthropod-borne viruses, the results of the mass serologic survey technique must be interpreted with the utmost caution. There is an immunological overlapping among the various members of the arthropod-borne viruses, and, too, certain of these viruses appear to require accessory labile human serum factors for the neutralization test. While this latter difficulty can be overcome by adding fresh normal human serum to all neutralization tests, there is no way to reduce the error which arises from the serologic relationships among viruses.

At the writer's laboratory in the Johns Hopkins University School of Hygiene and Public Health, we have approached the study of infectious diseases by attempting to analyze some of the ecological factors in the natural history of certain microparasites. Principally, we have been interested in the part played by the infected human or animal and in such phenomena as the origin of the first infection or case of the disease, the relation between infection and overt disease, the interepidemic reservoir, activation of latent infections, and factors in nature that determine the variation in virulence and antigenic composition of the causative agents. In all this work we have tried to use experimental conditions approximating as closely as possible those that appear to exist in nature. We have used the original isolation of the microparasite whenever possible and infected the experimental host in as natural a way as possible.

Many of our experiments during the past 5 years have been directed at understanding the factors influencing the survival of rickettsiae in nature. More recently, this work has been expanded to include human respiratory and arthropod-borne viruses.

The remaining part of this report is concerned with a general discussion of our results thus far together with the related findings of many other workers. Certainly, the point of view presented is not new, but it is one that has not received as much investigation as it deserves.

Attempts to solve these problems involve long-term studies. For this reason, particularly in our virus investigations, only preliminary data are available. The research program described in this report is a large and varied one. It was specifically organized in this manner in order to train workers in the use of a combined field-laboratory approach to disease problems. We have found that this is best done if the investigator is able to work with different diseases that have different survival mechanisms in nature.

The first experiments deal with the rickettsial diseases, Rocky Mountain spotted fever (RMSF) and epidemic typhus. Subsequent discussion deals with human respiratory diseases and certain arthropod-borne viruses.

Rickettsial Studies

It was established by the classical work of Ricketts (*10*) and Wolbach (*11*) that *Rickettsia rickettsii*, the etiological agent of RMSF, is maintained in nature, first, by transovarial and transtadial passage in various tick vectors, and, second, by infected ticks biting susceptible animals which can then infect uninfected ticks feeding on these animals. Early work by Spencer and Parker (*12*) and more recent studies in our laboratory have further shown that *R. rickettsii* can exist in its arthropod vectors in a phase that is avirulent for animals (*13*). Virulence can be restored by passage through one egg or by keeping the tick at 37°

C. for 24 hours or by a blood meal (*13*). The avirulent phase and its reactivation have been observed in the field, and it, therefore, may be presumed to play a role in the natural history of this agent (*13*).

This work shows that an infective agent may persist in the host's tissues over a long period of time in a form not detectable by laboratory techniques. In view of this possibility, the failure to detect an agent by the usual infectivity tests does not necessarily mean that the parasite is not present. Accordingly, when studying the natural history of a microparasite, it is desirable, when practical, to test for the presence of an agent not only by infectivity tests but also by challenging animals with a known virulent suspension of the organism being investigated or by interference tests (*14*). For example, in studying the natural history of a mosquito-borne virus, the failure of a mosquito suspension to cause disease when injected into a mouse does not necessarily mean that the agent is not present. It is conceivable that the agent is there but is in an avirulent, or masked form. This same mouse, challenged one month after the initial test inoculation with a virulent suspension of the virus, may prove to be immune because antibodies were stimulated by the avirulent phase.

Field observations and laboratory experiments with *Rickettsia prowazeki*, the etiological agent of epidemic typhus, have shown that many persons may harbor the microparasite years after infection (*15–17*). The microparasite may become reactivated and cause Brill's disease, or recrudescent typhus, in the hosts. These persons may then infect human body lice which feed on them (*16*). Man, therefore, may serve as an interepidemic reservoir for this agent, as originally proposed by Zinsser (*15*).

The question of latent infections and what activates them is one of the practical, fundamental problems of infectious diseases, both to host and to the scientist seeking to learn how the microparasite survives in nature. The importance of this problem was pointed out by some of the earliest investigators of infectious diseases, and more recently by Shope (*18*, *19*).

The primary objective of this type of study, of course, is to try to determine the factors that initiate infection. Once the disease occurs, the agent may be carried from host to host in a manner totally unrelated to the activation process. For example, in swine influenza the virus exists in the lung worm which is harbored in the lung of the swine. The virus is in a masked state. Following some provoking experience, the virus is activated; the animal then becomes sick with swine influenza and can spread the agent to other swine by contact (*19*). With typhus, once a louse feeds on a person who has recrudescent typhus, the louse to man to louse cycle can foment an epidemic.

It is still far from clear why specific microparasites vary in incidence and cause epidemics when they do, and why epidemics subside when they do. In our studies on RMSF, for example, seasonal tests on approximately 3,000 ticks for 4 successive years in an area in Maryland showed that the percentage of infected ticks varied only from 0.2 to 0.3 percent each year. Yet during this time there were each year many nonimmune susceptible animals and a countless number of uninfected ticks in the area. The uninfected ticks from this locality could be readily infected in the laboratory by strains isolated in the area. One possible conclusion is that one or more unknown factors in nature contribute to maintaining RMSF in this locality (*20*).

Influenza

Profile of an Epidemic

In our respiratory study, approximately 3,000 persons are under intensive observation; 800 of these are student nurses and medical school students in the Johns Hopkins Medical Institutions.

During the winter of 1954–55 there was an outbreak of influenza B in the 800 students. It began the middle of December, reached a peak the middle of January, and subsided about the second week of February. About 20 percent of the 800 subjects were infected with influenza B as determined serologically by the hemagglutination-inhibition test.

Some interesting data have been accumulated for the 240 student nurses in the group. These nurses are between the ages of 18 and 22. They all live in the same dormitory and eat at the same cafeteria. During the influenza B

outbreak approximately 20 percent of each of the first-, second-, and third-year classes showed serologic evidence of influenza B infection. Of primary importance, however, was the isolation in early January of three A-prime strains of influenza virus from three of the student nurses during the influenza B outbreak. The nurses from whom these viruses were isolated all showed at least a fourfold hemagglutination antibody rise against this virus and were clinically ill with influenza.

None of the other 237 nurses showed any evidence of influenza A-prime infection in serologic tests comparing blood samples taken in October with those taken the end of February and again in April. The hemagglutination-inhibition titers of their serums against these three A-prime isolations were low, 60 percent of them showing titers of less than 1 : 32. Seventy percent of the nurses showed blood-neutralizing serum titers of less than 1 : 32 against the A-prime virus. The neutralization antibody titer of their nasal secretions was usually about tenfold lower than the serum titer. These low titers were very similar to those observed when there was an A-prime influenza outbreak in the student nurse population in January 1952. As Francis (*21*), who was the first worker to find influenza antibody in nasal secretions, originally pointed out, the antibody titer of such secretions is very important if the pathogenesis of influenza is considered.

Here we have a situation in which the virus was present in a group that should contain a relatively large number of nonimmune persons. And yet there was no influenza A-prime epidemic, although conditions were favorable for an influenza B epidemic. The possibility that influenza B somehow kept the A-prime epidemic from developing must be considered, but it is difficult on the basis of what is known to believe that this is fact.

We have compared the virulence of the A-prime viruses isolated from the student nurse population during the peak of the epidemic in the winter of 1952 with the virulence of the A-prime viruses isolated from the three student nurses during January 1955. Samples of nasal secretions and throat washings from the latter three nurses and from three nurses clinically ill with influenza at the height of the 1952 epidemic showed no statistical difference in amount of virus. All samples were collected during the first 5 days of the disease and each sample was titrated in human embryonic kidney.

Two isolations from each year were tested. Five volunteers were used for each isolation, 20 in all. The viruses were all in the O phase representing the first amniotic passage. All inoculums contained the same number of particles as determined by titration in tissue culture using human embryonic kidney. The volunteers were between the ages of 19 and 26. They all had serum neutralizing antibody titers of less than 1 : 32 to the A-prime viruses. Two of them had a very slight neutralizing titer of 1 : 2 in their nasal secretions.

Eight of the ten volunteers inoculated with the 1952 epidemic strain and 7 of the 10 inoculated with the 1955 A-prime viruses developed clinical influenza. Both of the subjects who had slight neutralizing titers in their nasal secretions developed influenza. Four of the volunteers who did not develop clinical influenza had neutralizing titers in their serums and nasal secretions as high as those who developed influenza. The fifth volunteer who did not develop influenza showed a twofold increase in the neutralizing titer of his serum, but he had no detectable titer in his nasal secretions.

Similar results were obtained when the virus inoculums were diluted thirtyfold and given to another 20 volunteers.

On the basis of these tests there was no difference in the virulence of the strains of A-prime isolated in 1952 and 1955. We, therefore, have no clues as to why the A-prime epidemic occurred in January 1952 but not in 1955 since we have no evidence that antibody levels in the host or virulence of the influenza strains were the important determining factors.

The relation between antibody titer and resistance was further investigated in the 1954–55 influenza B outbreak among the student nurses and medical school students. From table 1 it is obvious that the higher the hemagglutination-inhibition titer of the individual's serum, the less chance he had of showing clinical influenza. The hemagglutination-inhibition titers given in table 1 were observed in October 1954, 2 months before the epidemic started, as measured against the influenza B virus causing the

Table 1. The relation between blood serum hemagglutination-inhibition (HA–I) titer, October 1954, and incidence of influenza B, December 1954–February 1955

Persons tested	HA–I titer	Percent showing clinical and serologic evidence of influenza B infection
50	<32	58. 0
73	32	35. 6
178	64	17. 4
119	128	7. 6
51	256	3. 9
9	512	1. 1
2	1, 024	0

epidemic. Epidemiological and laboratory studies indicated that in the student nurse group about 85 percent of those who developed influenza B had clinical illness, 15 percent of the cases being subclinical.

Many earlier workers have found that many persons with a high blood antibody titer seem to be more resistant to influenza than those with a low antibody titer. However, this statement is not uniformly true. In recorded instances, persons with high antibody titer have developed influenza and those with low antibody titer have escaped infection. In the student nurse group, many nurses with low blood and nasal neutralizing antibody titers escaped infection although they received as much exposure as those who developed influenza. And some of the infected nurses had much higher antibody titers, both in their serums and nasal secretions, against the epidemic strain.

It is of interest to speculate that perhaps genetic differences result in greater resistance or susceptibility, and we are examining this hypothesis.

Seasonal Incidence

Why most influenza epidemics occur in the winter bears on the whole enigma of the seasonal incidence of many infectious diseases. In the Baltimore area, for example, there is no record of an influenza epidemic between the months of May and November.

It is felt that three factors determine the response of the individual to influenza: exposure to the agent; antibody titer; and one or more unknown resistance factors. Proposed as a working hypothesis is the theory that the unknown factor is a virus resistance mechanism that is lowered during the winter months.

Studies made in an adult group over a 2-year period, from May to October of each year, in the Maryland area have shown that the influenza virus was not spread by subclinical infections in the group during summer months. Hemagglutination-inhibition titers of paired serums collected during these two periods failed to reveal one case of influenza in a population of more than 2,000 persons. About 10 percent of this group had influenza during the winter months of 1951, and about 20 percent of the group had influenza in the winter of 1952.

If influenza is being spread in this population during the summer months, it does not result in detectable antibody formation. We checked this point since it may have been argued that there were influenza cases during the summer months but for some reason such cases did not result in clinical symptoms.

Not only was no influenza found in our study group during the summer months, as measured by at least a fourfold rise in hemagglutination-inhibition titer, but the virus could not be recovered from these individuals 2 months before the 1952 influenza A-prime outbreak. Throat washings collected from 800 persons in the group the first 2 weeks of October 1951 failed to yield an A-prime isolate as determined by three amniotic chick embryo passages. In these tests each throat washing was inoculated into the amniotic sacs of three chick embryos. After 72 hours, the amniotic fluid was collected and tested for hemagglutination in the conventional manner, using human type O red blood cells. The three negative amniotic fluids were then combined, and this material was inoculated into three more chick embryos and tested as described. The whole procedure was repeated once more. During the winter epidemic the A-prime virus was readily isolated.

In 1954, during the first 2 weeks of November, we failed to isolate one influenza B virus strain from throat washings collected from 500 nurses in the Johns Hopkins Hospital. The attempted isolations from the throat washings were made by passing each washing three times

amniotically in chick embryo and testing for influenza virus at each egg passage by the conventional hemagglutination technique; 302 of these washings have also been passed in monkey kidney tissue culture without yielding any influenza B isolations. Thus, 6 weeks before the influenza outbreak occurred in the nursing group, no influenza B was isolated, although approximately 20 percent of the nurses contracted the virus infection from the end of December to the middle of February. Virus isolations of influenza B virus were readily made during the epidemic by the same methods that failed to yield virus isolations before the epidemic.

Although these results are admittedly based on small numbers, they do at least suggest that in these two instances neither the A-prime virus nor the influenza B virus had been widely seeded before the outbreak. These results are of interest in view of the hypothesis of Andrews (*22*) that the virus may be seeded in the population before erupting into an epidemic. It is, of course, always possible that the virus may be seeded in some form that cannot be detected by either the chick embryo or tissue culture techniques, or the virus may be in some tissue where it would not be collected by throat washings. Andrews presented his theory, in part, to account for the early summer "flurries" of influenza that have preceded many influenza outbreaks in late fall and winter. In all these instances, after the early summer cases of influenza there were no cases of influenza for several months preceding the epidemic. Although we have no evidence that the virus is seeded during this period, here again we have evidence that with the coming of summer months human cases of influenza stop occurring (*22*). However, in the late fall there is a sudden outbreak of the same influenza strain that had occurred in early summer.

Survival of Human Influenza in Nature

Much has been written about the biological survival mechanism of human influenza in nature. A good summary of the many hypotheses is contained in a recent article by Andrews (*22*). Although it is impossible in this article to go into all of the various aspects of the epidemiology of influenza, several points should be mentioned. First, there is no evidence that a host other than man is concerned with the survival of human influenza in nature. Second, one important survival mechanism of influenza is the spread of the virus from one country to another. But, even if one pictures a yearly swing between the Southern and Northern Hemispheres, influenza A does not break out in Europe every winter (*22*).

Although it is difficult to find influenza in a country between epidemics, the U. S. Army Commission on Respiratory Disease (*23*) reported that during World War II it was able to find influenza in the United States practically every month of the year. This being so, it would appear that influenza could be maintained sporadically throughout the year, with an epidemic when the environmental factors were right.

There are also several reasons for believing that the activation of latent influenza virus may be a factor in its survival, as first suggested by Shope (*24*). This is an extremely difficult problem to investigate because of the widespread nature of this disease and the difficulty of ruling out the possibility of infection from a contact. The fact that the Army commission found sporadic cases of influenza throughout the year does not rule out the possibility that some of the cases represented activation of latent influenza infections, much as Murray's (*25*) studies in Yugoslavia showed that some of the sporadic cases of louseborne typhus fever were really due to activation of latent typhus infections and not to louse bites.

During the summer of 1954, we isolated by tissue culture methods three influenza A-prime viruses from the lungs of patients who had undergone lung operations for various conditions. These strains were not laboratory contaminants since they did not kill mice, whereas the strains of influenza virus used in the laboratory killed mice readily. Since the last big A-prime epidemic was in the winter of 1952, it is felt that these patients had harbored the virus for at least 1½ years. Of course, this assumption would be difficult to prove because of the everpresent possibility of superinfection.

However, it seems to me that some of the persons who have an influenza infection compli-

cated by a bacterial infection might possibly harbor the virus in their lungs. It is of interest that the individuals from whom we isolated the A-prime virus did not have any evidence of clinical infection of influenza, according to their family physicians, for at least a year before their operations. But, here again the possibility of subclinical infection cannot be ruled out.

In support of the reactivation hypothesis, we have found that latent influenza infections in laboratory animals may be activated under certain environmental conditions.

Latent influenza infections have been reactivated in a number of ferrets that had recovered from a previous infection of influenza A-prime and were subjected to cold weather. This phenomenon has been identified by specific serologic tests. The same number of previously noninfected control ferrets showed no evidence of the disease when subjected to the same environmental conditions at the same time. At least two conditions seem essential in demonstrating this reactivation. The ferrets must have recovered from a severe influenza infection, and the influenza antibody titer, as measured by neutralization tests, must be low. It is not clear at present which organ or tissue contains the virus at the time of reactivation. In the only extensive tests made so far, using carefully perfused lungs of ferrets, no active virus was revealed in the lungs. In the tests, 20-percent suspensions of the lungs were passed three times in the amniotic and allantoic sacs of 11-day-old chick embryos. Infectivity was gauged by measuring the hemagglutination titer of the amniotic and allantoic fluids, using chicken and guinea pig red blood cells.

If an activation of a latent influenza infection does occur in nature, the question arises whether the latent virus exists in a fully infective form in some organ such as the lung or whether it exists in a "lysogenic" form. This latter virus phase has been described only for certain bacterial viruses (*26*).

In this phase, the virus exists in a noninfective phase (prophage) which appears to be attached to the bacterial nucleus. All attempts to detect the virus in this phase by splitting open the bacteria and testing for virus infectivity or by serologic tests are completely negative. When the cell divides, each daughter cell contains this incomplete virus. Under certain conditions, the prophage can be activated to form fully infective particles which are liberated from the cell and can then infect all other susceptible bacteria. This represents a model reservoir virus system, and a great deal of work is now going on in our laboratory, as well as in many other laboratories, in an attempt to see if such a situation exists for animal viruses.

It should, perhaps, be pointed out that the fairly rapid decline in antibody titer in humans and laboratory animals after influenza infection does not necessarily mean that the provirus could not be present in the host. Indeed, if a provirus of influenza did exist, it would not be expected to give rise to antibody formation since the provirus of any system that has been studied is not antigenic as tested by any known laboratory procedures.

Immunology and Virulence

Still to be answered is what determines the immunological and virulent properties of influenza virus in nature.

Some epidemiologists have voiced the opinion that the rise and fall of an epidemic is governed by the virulence of the agent. During the early part of the epidemic, they have speculated, the virulence of the agent may be increased by rapid passage from human to human, but as the number of immune individuals increases there is less frequent passage and the virulence of the strain is decreased.

Webster concluded that such changes in virulence play little, if any, role in determining the rise and fall of epidemic waves (*27*). His experiments, however, were carried out under laboratory conditions with particular bacterial systems. In the natural state, parasites encounter ecological situations far more complex than in the laboratory, and such situations conceivably can influence virulence. For example, changes in the micro-organism may occur when such agents infect persons possessing antibody.

There is no doubt that influenza isolations do vary in virulence and antigenic composition in an epidemic. In 1952 in a hospital ward at a home for the aged in Baltimore, we made 13 virus isolations during an outbreak of influenza A-prime. Careful study showed that this out-

break arose from the introduction of an infected person into the ward.

Using a combination of 10 A and A-prime influenza viruses and the absorption technique of Jensen and Francis (*28*), we demonstrated immunological differences among these 13 isolates. For example, an isolate from one patient showed major antigenic components related to the Sweden and Rome prototypes, while another isolate showed major components only to the Sweden and English prototypes. A third isolate was related only to the Rome and Malayan influenza virus prototypes. There was no apparent relation between the antigenic composition of the virus isolated and antibody levels before or after infection.

All viruses isolated were passed five times in chick embryos before being used for the absorption tests. The three differing isolates described were also "purified" by three limiting dilutions in chick embryos, the second chick embryo passage being used for the dilution "purification." This was done in order to work with clones as pure as possible. Viruses prepared in this manner still showed the same immunological differences.

The 13 virus isolates could also be broken up into three groups on the basis of their behavior in chick embryos, ferrets, mice, and by tissue culture. In these tests the isolations also were purified by the limiting dilution technique. Although compared on a quantitative basis at various dilutions, 2 of the strains could not be established in ferrets even after four blind passages; 8 of the strains gave a good reaction in ferrets, and 1 isolation resulted in a mild reaction in the animals.

Some investigators have recently proposed that the recombination phenomenon might be important in determining the virulence and immunological properties of influenza viruses in nature. In this phenomenon, reproduced under laboratory conditions, two strains of influenza virus infect a cell, and some cells yield a virus that is different from the original two infecting viruses (*1*, *29*). However, whether such a phenomenon occurs under natural conditions is open to speculation. Taylor (*30*) has suggested that perhaps the passage of influenza virus through persons having antibodies to various influenza types would have some part in determining the immunological and perhaps the virulent properties of influenza strains that appear in nature. Work by Archetti and Horsfall (*31*) and Gerber and co-workers (*32*) have shown that Taylor's hypothesis can be made to operate in the laboratory.

In further work, we have experimented on the effect of subsequent influenza infection upon the antibody response of laboratory animals previously infected with various influenza viruses. The objective was to obtain a laboratory model to test further the interesting theories of Francis and co-workers that the initial influenza virus infection is important in determining the type of antibody produced by a subsequent influenza infection. They based this idea on a survey of the influenza antibody titers of different age groups. We used 5-week-old Swiss mice and inoculated them intranasally with influenza A-prime virus (FW–1–50), an A-type virus (WS), or swine influenza. Enough virus was inoculated to kill about 15 percent of the animals in all groups. Fifty days after infection the surviving mice in each group were divided into three groups and inoculated intraperitoneally as shown in a typical experiment (table 2). Antibodies were tested by the neutralization test in mice. It is apparent in table 2 that the first infection determined the type of antibody formed when the mice were vaccinated with the different influenza strains.

It was thought of interest to challenge mice intranasally after observing the intraperitoneal effects, since an intranasal test would approximate the conditions in nature. In these tests the mice had a greater tendency to produce antibody to the second virus infection than the first (table 2). It is felt that the mice were truly infected by the intranasal inoculation, whereas they were merely vaccinated by the intraperitoneal route. This may account for the difference in antibody response.

In order to test whether the above phenomenon might occur in humans on immunization, 10 children, 6 to 10 years old, were injected with a swine influenza vaccine. These children had no neutralizing antibodies against the swine influenza virus when their serums were tested in a dilution of 1:16. Their neutralizing titers varied between 1:64–1:128 against the FM1 strain of influenza. Three weeks after

vaccination with swine influenza, 8 of the 10 children showed neutralizing titers to swine influenza between 1:64–1:256 (mean titer 1:128). However, their titers to FM1 varied between 1:512–1:4096 (mean titer 1:2048).

Five adults, ages 40 to 45, were injected with the same amount of swine influenza vaccine. These adults had initial titers to swine influenza between 1:64–1:256. Their initial titers to FM1 varied between 1:32–1:128. Three weeks after the injection of the same amount and the same swine influenza vaccine that the children received, they showed titers to swine influenza virus varying between 1:512–1:2048. Their FM1 neutralizing titer varied from 1:512–1:2048 (mean titer 1:1024). These results appear similar to those reported for the mice, since the adults, according to the work of Francis, would have had early experience with swine influenza while the children would not.

This work, therefore, supports the hypothesis of Francis that the initial influenza virus infections orient the antibody response produced by subsequent influenza infections under the experimental conditions employed.

It would appear that this phenomenon is not only of importance in the natural history of influenza, but would also be of great importance in considering how to control this disease.

RI-APC Viruses

Another puzzling problem in respiratory viruses is that concerned with the natural history of the new RI-APC group. Hilleman (*33*) found that 70 to 80 percent of the recruits entering the Army got the APC infection 9 months after they were inducted. Of those recruits inducted during the winter, 70 to 80

Table 2. The effect on antibody response of intraperitoneal and intranasal inoculation of influenza viruses in mice previously infected with different influenza viruses

Primary infection type	Secondary treatment, intraperitioneal or intranasal, 50 days later	Viruses tested against	Mouse neutralization titer X increase after second treatment [1]	
			Intraperitoneal	Intranasal
FW-1-50	Swine	Swine	16	4
		WS	4	2
		FW-1-50	64	64
	FW-1-50	Swine	0	4
		WS	0	0
		FW-1-50	128	64
	WS	Swine	0	16
		WS	4	8
		FW-1-50	128	0
Swine	Swine	Swine	512	64
		WS	2	2
		FW-1-50	0	8
	FW-1-50	Swine	64	0
		WS	0	0
		FW-1-50	4	64
	WS	Swine	128	64
		WS	4	8
		FW-1-50	0	2
WS	Swine	Swine	0	64
		WS	8	32
		FW-1-50	2	4
	FW-1-50	Swine	0	8
		WS	16	4
		FW-1-50	2	4
	WS	Swine	0	8
		WS	128	64
		FW-1-50	0	2

NOTE: The above experiment was repeated 3 times with similar results. Influenza B given as the secondary treatment did not cause any increase in antibodies to WS, FW-1-50, or swine influenza virus.

[1] The serums of 4 mice were pooled for each test.

370566—56——3

percent developed the respiratory infection within 2 or 3 months after joining the Army. RI–APC virus types 4 and 7 appear to be involved.

During a study of 2,015 first-year student nurses, medical school students, and college freshmen in Maryland, Pennsylvania, and New Jersey for a little over 2 years, only 4 percent of them developed APC infections. Methods described by Hilleman (*34*) were used to detect infection. Blood samples were taken every 4 months over a 24-month period. The APC complement fixation (CF) titers of the serums collected at the first interval were compared with the titers of the serums collected at the subsequent intervals. Since the APC antigen reacts with all types of the RI–APC viruses (*35*), failure to detect an increase in titer against the APC antigen would indicate that these students did not develop any type of APC infection which resulted in a titer increase. Since we have found that with an APC infection the complement fixation titer remains at an elevated level for at least 4 months, the interval between tests should have been adequate to detect any antibody rise.

In view of the large number of recruits who came down with APC infections, we feel it surprising that so few of our study group showed the same type of infections since 80 percent of them were of the same sex and age as were the recruits and were subjected to similar, but by no means identical, environment.

In the student nurse group at the Johns Hopkins Hospital, four of the students developed infection with type 3 virus of the RI–APC group. Ninety-one immediate contacts, including roommates of these four nurses, were intensively studied by serologic tests and isolation attempts for 5 weeks (*34*). In spite of the fact that the serums of 71 percent of these contacts showed no complement fixation titer to APC viruses at a dilution of 1:4 or no neutralization titers at a dilution of 1:2 against type 3 virus, not one of the individuals showed any signs of APC infection.

In another study of 1,051 human respiratory illnesses in adults from the outpatient departments of the Johns Hopkins Hospital, Sinai Hospital, and Baltimore City Hospital, which laboratory data showed were not influenza or of bacterial origin, only 4 percent of the illnesses were found to be caused by RI–APC viruses.

A similar low value has so far been found in 1,115 other persons we have been following in the Maryland area. This group is made up of families, adults with chronic disease, and adults between the ages of 60 and 80 who have no chronic physical ailments. Blood samples are taken every 4 months. The RI–APC complement fixation titer of their serums is then compared to their baseline level. Only 4.3 percent have shown rises in their RI–APC CF titer during the 1-year observation period. These rises would include not only clinical infection but subclinical infection with the RI–APC agents.

All these data would seem to indicate that much more investigation is needed before we can be sure just how important the RI–APC viruses are in the civilian population. It is entirely possible that the RI–APC agents may be of clinical importance in children in the civilian population, but this still would not explain why Hilleman found a 70 to 80 percent infection rate in recruits during their first 9 months in the Army.

We have no clues as yet as to why recruits develop such a high incidence of the disease. A combination of emotional strain, physical activity, and hygienic conditions or physical activity and hygienic conditions alone may be the determining factors, since the recruits are subjected to much more strenuous exercise and poorer hygienic conditions than the student group we are observing.

The work of Huebner and co-workers (*35*), who observed that the RI–APC viruses can be found in the adenoids and tonsils of many normal individuals, leads me to wonder whether activation of latent infections may also enter into the survival mechanism of these viruses in nature.

Arthropod-Borne Viruses

Serologic Relationships

Recent work by several investigators has revealed that certain arthropod-borne viruses are more closely related immunologically than had

been thought (*36–39*). Work in this laboratory has been done on West Nile (WN), Japanese B (JB), Murray Valley (MV), and St. Louis (SL) viruses.

We have found that hamsters infected with Japanese B virus and permitted to recover are protected against a subcutaneous challenge of approximately 100 LD_{50} of West Nile or Murray Valley virus. Previous failure to observe the cross-protection between these viruses was due to the fact that in all preceding experiments mice were challenged intracerebrally. In order to see whether this immunological relationship affected the natural history of these viruses, the following experiments were carried out.

Three-day-old chicks were infected at intervals with 100 mouse LD_{50} of JB virus and were later mated. The nestlings of these birds were subjected to further study since work of others indicates that nestling birds have an important part in the epidemiology of these arthropod-borne viruses. The nestling progeny of the infected birds contained antibody to the JB virus which was transferred through the egg from the hen. These nestlings were then infected when 4 days old by subcutaneous inoculation with 1–10 mouse LD_{50} of WN virus or by the bite of *Aedes aegypti* infected with WN virus. Similar results were obtained with both methods of infection. Birds of the same age, species, and not previously infected were used as controls. The control birds showed maximum viremias to WN virus of approximately 10^4 mouse LD_{50}, whereas the progeny of the birds previously infected with JB virus showed a maximum viremia of approximately 10 mouse LD_{50} per 0.03 ml. of blood. Half of the uninfected *A. aegypti* feeding on the control birds became infected with WN virus. The West Nile virus was found in only 4 of the 100 tested uninfected mosquitoes which fed on the birds previously infected with JB virus and then WN virus.

The tests for WN virus were made by incubating the mosquitoes for 14 days, making suspensions of them, and inoculating these suspensions into suckling mice, 4 mice being used for each suspension. In all experiments mosquitoes of the same age and lot were used and were fed at the same time in the same numbers 1 and 2 days before the maximum viremia as well as on the day of the maximum viremia.

In experiments conducted to test the transmission potential of the two lots of mosquitoes in one-half-day-old chicks, 28 percent of the mosquitoes that fed on the control birds were capable of transmission, whereas only 2 of the 100 mosquitoes tested in the group which had fed on the nestlings previously infected with JB virus were capable of transmitting WN virus.

All of the mosquitoes from this latter lot were also tested for WN virus after their transmission tests. They were kept for 5 days at room temperature and ground up. The suspensions were injected into mice. Two mosquitoes showed evidence of WN infection. All mosquitoes were kept for 21 days before virus transmission to chicks was attempted. Similar results were obtained in the above test system when Murray Valley or St. Louis encephalitis viruses were substituted for Japanese B virus.

These experiments approach conditions found in nature. In certain areas where a large majority of animals and humans have been infected with one type of the viruses mentioned, the serologic overlapping may tend to limit the chances that a related arthropod-borne virus will establish a foothold in the area, the result depending upon the viruses involved. It is also apparent that previous infection with one of the viruses will be of obvious importance in determining whether an individual infected with a related arthropod-borne virus develops an overt disease. In this connection, one wonders whether all the arthropod-borne viruses should be classed as neurotropic viruses. It is perfectly true that some cases result in neurotropic symptoms. However, for every host that develops neurotropic symptoms of Japanese B, Murray Valley, or St. Louis encephalitis, there may well be a thousand infected individuals who show no clinical symptoms (*1*). The neurotropic virus may be a rare type in the virus population, most of the viruses that make up the various members of this group being non-neurotropic.

The isolation of these viruses by intracerebral inoculation of mice would favor the isolation of any neurotropic variants. It would be of particular interest to compare the viruses thus iso-

lated with those isolated by chick embryo techniques and various tissue culture procedures.

This problem is important. If the three viruses are not truly neurotropic, the pathogenesis of these diseases would have to be viewed in a different light, and the failure of most individuals to show neurotropic symptoms would not be due primarily to the resistance mechanism of the host but to the virus which infected the host.

This immunological relationship between arthropod-borne viruses may also have practical application in working out vaccination procedure against certain of these arthropod-borne viruses. For example, the killed Japanese B vaccine now in use gives little protection against the virus as measured by its ability to elicit neutralizing antibody. However, we have observed that if the same amount of killed JB vaccine is given to persons who had no previous exposure to JB virus but who had a previous WN infection, a considerable increase in JB neutralizing antibodies is observed (table 3). Serum samples of the 14 subjects were tested before treatment. None of their serums diluted 1:2 neutralized 30 mouse LD_{50} of JB virus. Six weeks after the subjects had been infected with West Nile virus or injected with killed Japanese B vaccine, they were given a subsequent intramuscular injection of the killed JB virus vaccine. All serum dilutions were made in fresh normal human serum. None of this latter serum neutralized 30 mouse LD_{50} of JB virus when diluted 1:2. The values in table 3 give the maximum neutralization titer after the initial treatment and 6 weeks after the subsequent killed JB vaccine injection. Weekly blood samples were taken.

We do not know as yet how long these antibodies will last in such individuals. However, it seems to me that it may be possible by using an attenuated strain of one of the arthropod-borne viruses such as WN, which shows serologic overlapping with many of the other viruses, to immunize the individual in such a manner that he can then be vaccinated much more efficiently with killed vaccines of the more virulent related viruses. It is also possible that if a person had a WN infection and was then vaccinated with JB killed vaccine, he would not only get better protection against JB virus but would have some protection against other related viruses. In other words, WN infection or JB killed virus vaccine by itself would give little if any protection against Russian spring-summer (RSS) virus. But the combination of living WN infection plus killed JB vaccine may result in protection against RSS virus because of the immunological overlapping between WN, JB, and RSS viruses.

Table 3. The effect of previous infection with West Nile virus on a subsequent injection with killed Japanese B virus [1]

Initial treatment	Neutralization titer to Japanese B virus after initial treatment	Neutralization titer after subsequent injection of Japanese B killed vaccine
West Nile infection	1:10	1:100
	1:5	1:80
	0	1:40
	0	1:60
	0	1:100
Killed Japanese B vaccine	0	0
	0	0
	0	0
	0	1:4
	0	0
	0	0
	0	0
	0	0
	0	0

[1] All titers refer to dilutions of serum which will protect 4 of 8 mice against approximately 30 LD_{50} of Japanese B virus.

Our preliminary data support this hypothesis, and we are now in the process of determining which two viruses will give the best protection against a whole group of serologically related arthropod-borne viruses.

Immunological overlapping may also play a role in the evolution of some of these arthropod-borne viruses. For example, we have shown that if a host has antibodies to Japanese B virus and is infected with West Nile virus the multiplication of West Nile virus may be greatly inhibited.

However, if one infectious dose of WN virus were to contain a few particles that differ in their antigenic composition from the majority of WN particles, that is, if they were less closely related immunologically to Japanese B virus, these particles might multiply in the

above circumstances to the exclusion of the predominating WN particles. This situation would lead to a new antigenic WN virus population. If some of these virus particles were to multiply in another species of mosquito vector than can support the growth and transmission of the WN particles now predominating in nature, this insect vector could act as a further selective medium and give rise to a much different virus than the existing WN virus.

In view of what we know about the biology of viruses, such a speculation must be considered in a discussion of the natural history of arthropod-borne viruses.

Survival Mechanism

The big question that remains to be solved concerning the biological survival mechanisms of the arthropod-borne viruses is how they maintain themselves between epidemics. In spite of the brilliant work of the Rockefeller Foundation, we still cannot answer this question for yellow fever, nor indeed for any arthropod-borne virus. In this country, western equine encephalitis poses a similar problem. No ecological complex has as yet been described which will satisfy all the requirements for an interepidemic reservoir. It is possible that the western equine encephalitis virus is harbored by overwintering mosquitoes. Another possibility is that the activation of latent virus infections in the animal host may play a role in the survival mechanisms of some of the arthropod-borne viruses.

Many experiments in this laboratory carried out with various species of hard ticks as possible reservoirs for western equine encephalitis have been entirely negative. However, we have observed in this laboratory that Japanese B virus loses its infectivity for a time when grown in mosquito tissue culture. The methods used would have detected about 10 Japanese B virus infective particles. When active virus appears, the increase is much greater than could be accounted for on the basis of a few infective particles multiplying and giving rise to more infective virus. It appears that in the mosquito vector this virus goes through an eclipse phase similar to that described for many animal viruses in animal cells as well as for bacterial viruses in bacteria (*1*). Similar results have been reported for Murray Valley virus in *Culex annulirostris* by McLean (*40*). These findings, therefore, together with the fact that the multiplication of these arthropod-borne viruses in their insect vector does not appear to damage their cells, make one consider the possibility that in a few mosquitoes the virus may exist in a provirus-like state (*26*). In this phase the virus would be noninfective and nonantigenic under all the usual experimental conditions, but it could be activated into infective virus under certain conditions.

Conclusion

Although the task of curbing epidemics rarely confronts us in the United States, a major responsibility of public health today consists of anticipating and preventing epidemics. This phase of preventive medicine needs to be supported by studies of the interepidemic history of infectious organisms.

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Unfinished Business in Maternal and Child Nutrition

By MARJORIE M. HESELTINE, M.A.

PROGRESS in recent years makes it possible to talk now about unfinished business in maternal and child nutrition. Even though we lack precise measures of nutritional status, few people doubt that mothers and children, on the average, are in better nutritional condition today than they were 20 years ago. But the very size of our accomplishments makes it necessary to emphasize that there is unfinished business. Some people seem to think we can afford to forget about nutrition programs for mothers and children and turn our attention entirely to overfed adults and the chronically ill of all ages. I dissent. Let me tell you why.

First, there is the magnitude of the problem. As Dr. Martha Eliot, chief of the Children's Bureau, pointed out to the Association of State and Territorial Health Officers in 1952, this Nation is growing younger faster than it is growing older (*1*). Realizing that this statement was contrary to the prevailing impression, she went on to say that during the preceding decade, the population over 65 years of age had increased 37 percent but the population under 5 had grown by 55 percent.

Miss Heseltine is chief of the Nutrition Section, Division of Health Services, Children's Bureau, Social Security Administration. Since this paper is based on her address at the 1955 meeting of the Western Branch of the American Public Health Association, the illustrations are drawn largely from the western part of the country.

Because of improved maternal care, the 4 million babies that are born annually may be spared many of the hazards of delivery and early infancy. But their birth certificates carry no guarantee that they will receive the daily dietary allowances recommended by the National Research Council. If an infant is to get the food he needs for optimal growth (please note that I do not say maximal growth, a point I shall discuss later) under conditions that make for good physical and emotional development, parent education in nutrition must go on and on as long as women have babies. Then, too, there is sufficient indication that what happens during childhood has a bearing on health during adult life to warrant continuing attention to maternal and child nutrition if only for its long-range influence on health problems of later maturity, which are now so much in the limelight. Public health nutrition services should be directed toward the older age groups, but programs should continue to serve maternal and child health as well.

My colleagues in State child health and crippled children's programs offer another reason for urging no diminution in maternal and child nutrition work: Generalized undernutrition, they say, can still be found among children in the United States, and even cases of dietary deficiency disease are seen occasionally from cultural groups that have not shared in the widespread economic prosperity. It is true that we have to look much more sharply for instances of malnutrition than we once did, but those we see are all the more dis-

tressing in these prosperous times. The comments of a young nutrition trainee from a so-called underdeveloped country after she had taken part in a dietary survey among low-income rural families in the United States are pertinent here. In a personal letter to an understanding American friend, she wrote: "Speaking of diet, I believe that the poor people of these counties . . . have a diet more deficient than the poor of my country. In a large family of 8 members, one housewife here reported that they spent only $5 a week for food. This whole family is ill, and no wonder. And like this family, there are others and others. I also have the impression that these people show a greater sadness because they see from so close the comforts that they would like to attain."

The task ahead in maternal and child nutrition falls into two main categories, as I see it. We need to know more, much more. We need to do more with what we already know, and even with hypotheses that we think may be confirmed by research.

Requirements for Optimal Health

Of the many aspects of maternal and child nutrition that we need to know more about and to do more about, one is the matter of nutritional requirements for optimal health at all stages of development. In 1953 the Food and Nutrition Board of the National Research Council issued the third revision since 1943 of its Recommended Dietary Allowances (*2*). The ink was hardly dry on this revision before the recommendations for protein allowances during the first year of life were challenged as being unnecessarily liberal. A committee of the board is now reconsidering these recommendations, and the Academy of Pediatrics has appointed a committee on nutrition which will direct attention to the matter. These recommendations, which represent "nutrient levels selected to cover individual variations in a substantial majority of the population" and which must never be confused with minimal requirements for an individual, are sure to be revised again and again as research throws more light on nutritional needs.

We need to know much more about satisfactory rates of growth in children. As two research workers said, we need to find the "answer to the important medical-nutritional question regarding the degree of conformity to a norm to be expected on the part of an otherwise healthy child" (*3*). Longitudinal studies, such as those now under way at the Colorado Child Research Council, have already given us a respect for individual differences (*4*).

Although it is not easy for Americans to give up our "bigger and better" concept, there are those who are impressed by the questions raised by Prof. R. A. McCance of London. He asks whether the attainment of large size through very rapid rates of growth is in the interests of optimal health either during childhood or in later life. The following statements from one of his lectures may whet your appetite to seek out his provocative papers on overnutrition and undernutrition (*5*): "Animal husbandmen have bred and fed their animals for rapid maturity and marketable qualities and political husbandmen have come near to doing the same for children. Curiously little work or thought has been devoted to a study of the desirable plane of nutrition for the different years of human endeavor."

Introduction of Solid Foods

If infants are not expected to grow at ever more rapid rates, there may be some revision in our ideas about the time for introduction of solid foods into the diet. The Child Health Center at the University of Washington has pioneered in trying to discover whether there is any difference in the progress of babies given solids by the end of the fourth week and those not given solid foods until the age of 9 to 12 weeks. Two researchers at the center could not detect any significant difference in the development of the two groups of infants in their response to solid foods (*6*).

Another approach to this question was taken by a group of pediatricians. By means of questionnaires, they obtained information from more than 2,000 of their colleagues in all parts of the country (*7*). There was general recognition of the trend toward early introduction of solid foods, but as one pediatrician put it: "The major factors underlying the current

trend to earlier feeding of solid foods are more probably social than they are nutritional or medical." And in case anyone thinks that parents take their pediatrician's recommendations without demurring, you should know that 59 percent of the pediatricians reported that they "experienced considerable pressure on the part of the mothers for the early introduction of solid foods." The consensus was that there is no physiological basis for introducing solid foods before the age of 3 months.

For Healthy Teeth

Still another aspect of maternal and child nutrition about which we need to know much more is the relation of nutrition to healthy teeth and to their resistance to caries. It seems to be well established that the development of structurally sound teeth is dependent on a supply of nutrients that have their source in the ingested food. The argument begins on the question of the effect of diet on the susceptibility to caries of the fully formed tooth. Many discussions have been devoted to that topic, but the net result, it seems to me, is that the proponents of the various schools of thought have become more convinced than ever of the validity of their evidence whereas neutrals have become only more confused.

Fortunately, research on this question continues, and the prospects of an answer become brighter through the use of such new tools as electron microscopy and radioactive tracer techniques. There is certainly some indication from recent studies that enamel is permeable both from the oral cavity and the bloodstream.

Diet and Pregnancy

We need to know more about the relationship of diet preceding and during pregnancy to the well-being of the mother and infant. Teams of research workers in various medical centers have approached the study of nutrition during pregnancy quite differently and, as might be expected, have often failed to confirm each other's findings. Does that mean that we should no longer claim that what a woman eats during the maternity cycle is important? A question as direct as that was put by a nutrition workshop participant last summer to a young obstetrician who had just reported that a large-scale study had failed to reveal major differences between the nutritional condition of women who had had good diets and those who had had poor diets during pregnancy. As this physician was known to be an expectant father, he was asked: "What are you advising your wife to eat?" Thereupon, the nutritionists listened to the kind of dietary recommendations that they wish every pregnant woman might receive from her physician. His study may not have shown that diets somewhat below prevailing standards of adequacy had had a deleterious effect; but he was well aware of other studies that had shown diet to be important, and he wanted his wife to have the benefit of the doubt.

There would seem to be some rather impressive evidence in regard to the consequences of drastic limitation of calorie intake during pregnancy. Studies in Chicago have shown that when the energy requirements of the pregnant woman are not met, storage of nitrogen in the form of protein does not proceed at a satisfactory rate (*8*). Other studies indicate that women who are underweight at the beginning of pregnancy and who fail to come within a normal range during the first two trimesters have a higher than average proportion of premature infants (*9*). Nevertheless, I have been told of a teaching hospital that has only recently abandoned the routine prescription of a 1,000-calorie diet for prenatal clinic patients. The woman who is given such slim rations is sometimes told that it is important to control the size of the fetus. Yet there is impressive evidence that a diet so restricted as to affect the weight of the infant is pretty sure to take its toll on the mother. Periods of famine do result in lower birth weights. They also are likely to impair the health of childbearing women.

Nutrition Education

Thus far, I have dealt only with the need for extending our knowledge of nutritional requirements and with the importance of putting into practice the concepts that have been evolved by our most authoritative leaders. But in order to put into effect what we know about nutrition, we need to know more—much more—about the

people to whom nutritional programs are directed.

Nutrition education has come a long way since the days when the nutritionist was a feminine lone ranger, who prepared her own educational material (usually mimeographed, single spaced), jumped into her car, traveled across the State to a county where there might or might not be a public health nurse, rounded up a group to listen to her talk or watch a demonstration, got back into her car, and returned to the State office. In those days, the public health nurse was not expected to know anything about nutrition. If she strayed beyond underlining the appropriate paragraphs about diet in the pamphlet she handed to a parent, she did so at her own risk. Community organization, group dynamics, the consultant-consultee relationship—all these were concepts that she had never heard of. There was no thought given to modifying teaching about foods to fit cultural patterns, for the emphasis was on Americanization. If cream soups were accepted by middle income Anglo-Americans, it was assumed the sooner recently immigrated Mexican mothers learned to make cream soup the sooner they would evolve into 100-percent Americans.

Currently, nutrition enters into the daily activities of many kinds of public health workers. A large proportion of them are equipped by training and experience to deal effectively with the run-of-the-mill nutrition problems, although, of course, they recognize the need for technical assistance from a nutritionist—hopefully one who is accessible enough to give help when it is most desired. Increasingly, nutrition consultation is focused not on what is new in nutrition but on how to make what is old (and as far as we know still true) function in the lives of people. Maternal and child nutrition teaching has been profoundly influenced by the writings of such men as Aldrich, Senn, Richmond, and Spock. Good nutrition is viewed not as an end in itself but as one factor in the development of a sound body and a healthy personality.

Knowing what is considered an appropriate diet for a parturient woman and her infant and why certain values are attributed to certain foods is only the starting point for soundly motivated education in maternal nutrition. Beyond this, we must understand the ways of life of the people whom we are trying to teach. In work with cultural groups that have different value systems from their own, public health workers have found a new ally in the anthropologist. A paper on midwife training by Dr. Isabel Kelly (*10*), an anthropologist with the United States Operations Mission to Mexico, provides the following illustration of how a health worker and a social scientist may cooperate in solving a problem:

In certain Mexican villages, the women were unwilling to drink water during the later months of pregnancy or to give either water or fruit juice to their babies. As a result, both mother and child were deprived of essential fluids, and the child did not get the necessary amounts of vitamin C. Dr. Kelly and a nurse midwife worked out this solution: an increase in consumption of the herb teas that are an accepted part of the diet of these people and addition of an ascorbic acid tablet to the tea before it is given to the babies. The women were quite willing to make these modifications in their habits.

Dr. Kelly does not suggest that the practices found in these villages will persist indefinitely; she merely points out how a practice may serve effectively for the present. As Dr. Cicely Williams, who has done maternal and child health work in many parts of the British Commonwealth, states in an article on nutrition (*11*), "Many of the customs recorded by social anthropologists are not (as commonly supposed) unalterable but can be replaced by more rational and advantageous behavior once the position has been explained and understood. Often one sees the term 'social and cultural customs' used to dignify habits which are merely the result of ignorance and carelessness."

Health Agencies and Research

Not only can health departments do more about applying what is known in nutrition, they can also contribute to the knowledge that is to be translated into programs. I am not suggesting that health departments should embark singlehandedly on ambitious nutrition research projects; but I am suggesting that they can

cooperate with other agencies in mutually beneficial programs and that they can undertake modest factfinding activities on their own.

As an example of the former, I am thinking of a statewide study of food habits of families with children that was conducted by the New Mexico Department of Public Health and nutritionists in the New Mexico Agricultural Experiment Station (*12*). As a result of this study, the health department has a much sounder basis for its nutrition programs in behalf of children.

I could cite many examples of the latter, but I will mention only two. A district nutritionist in Florida, with help from the State health department, worked out a device for learning what some of the words that come trippingly on the tongues of prenatal clinic staff mean to the patients. She learned, among other things (*13*), that to some of the patients "nutrition" is "the man who lays out dead folks." We can well believe that clinicians and nurses in that part of Florida will no longer tell a prenatal patient to "talk to Miss C . . . about your nutrition." In a county health department in California, a Spanish-speaking nurse, with the encouragement of her supervisor and help from a State nutrition consultant, undertook to find out what the Mexican-American families in her district were eating. The data she obtained would not permit an easy generalization. There was as much disparity between low-income and prosperous families as would be found in an Anglo-American group.

In conclusion, let me emphasize that the unfinished business in maternal and child nutrition is to a large extent the business of all public health workers. Seek help from the nutritionists and complain long and loud when you can't get it. But don't expect the nutritionist to do the job alone.

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The Use of Insecticide Treated Cords for Housefly Control

By JOHN W. KILPATRICK, M.S., and H. F. SCHOOF, Ph.D.

IN RECENT years, the resistance of houseflies to residual treatments of DDT and other chlorinated hydrocarbon insecticides has stimulated intensive search for new insecticide materials and control techniques. Numerous synergistic compounds have been screened in an effort to develop a chemical formulation effective against insecticide-resistant houseflies (*1–3*). Other fly control methods include larviciding (*4*), space spraying (*5*), and poison baits (*6–8*).

Baker and co-workers (*9*) evaluated the effectiveness of DDT-treated cords for housefly control in food establishments, while Pimentel and associates (*10*) used screen strips treated with high concentrations of dieldrin and festooned from barn ceilings as a means of controlling houseflies in dairies. Variations in these techniques have included the use of cords impregnated with other insecticides, including organophosphorus compounds. Laboratory studies of Fay and Lindquist (*11*) indicated the type, size, and color of cords most suitable for treatment and the effective concentrations of the dipping solution. Maier and Mathis (*12*) in 1952 demonstrated that cotton cords $3/16$ inch in diameter treated with parathion gave considerable promise as a method of fly control in dairy barns near Savannah, Ga. Further field tests in 1953 in rural areas (*13*) and in dairy barns substantiated these earlier results. These tests indicated that cotton cords $3/16$ inch and $3/32$ inch in diameter impregnated with parathion produced satisfactory control of flies in dairies and rural areas when the cords were installed at the rate of 8–15 linear feet of cord per 100 square feet of floor area.

In 1954, field studies with cotton cords $3/32$ inch in diameter were designed to evaluate different installation techniques, cord dosages, and chemicals (parathion and Diazinon). Cord installations were tested in dairy barns, rural areas, and military dining halls.

Mr. Kilpatrick and Dr. Schoof are entomologists with the Technical Development Laboratories, Communicable Disease Center, Public Health Service, Savannah, Ga. Dr. Schoof is chief of the Biology Section of the laboratories.

Methods

Cotton cords were treated by immersion in either a 7.5-percent or a 10-percent parathion-xylene solution which, by chemical analysis, showed a dosage of 75–100 mg. of parathion per linear foot of cord. For uniform impregnation, the cords remained in the insecticide solution for approximately 2 minutes. The Diazinon-treated cords were impregnated by dipping them in either a 10-percent or a 25-percent (an estimated 200–250 mg. per linear foot) Diazinon-xylene solution. All cords were installed at the rate of 30 linear feet of cord per 100 square feet of floor area, with the exception of one test with Diazinon-impregnated cords in which the dosage was reduced to 25 linear feet of cord to 100 feet of floor space. The cords

Figure 1. Insecticide-impregnated cords installed in a feedroom of a dairy.

were suspended vertically either from the ceiling or from horizontal cords extending from wall to wall (fig. 1).

In dairies and rural areas, the cords were installed at all protected potential fly-resting sites, particularly those within barns, pigpens, calf pens, and chickenhouses. In the rural area tests, treated cords also were suspended in the kitchens and on porches of unscreened houses. Treatments in military food establishments included complete installation of cords in the dining halls and partial treatment of the kitchens. In the kitchens, cords were placed so that the affected flies would have little chance of falling into food-preparation sites. Cords also were installed beneath the overhang of the entranceways.

Appraisal of the housefly populations in dairies was accomplished by selecting the highest grill count (5 counts per station) from each of 4 stations. These stations were not fixed sites but general areas, such as stanchions, entranceways, and feedrooms. The average of the four highest counts constituted the weekly fly index. In the rural areas, 5 grill counts were made on each of 10 premises every week. The highest count at each of the premises was recorded, and the average of these counts was employed as a weekly index. In the unscreened kitchens, total fly counts were recorded. In military dining halls, the weekly fly index was made by obtaining a total count of houseflies found in the kitchen and dining hall. The fly densities were evaluated during the same time interval each week to avoid, as much as possible, variations in fly behavior.

All dairies used in the study maintained herds of 100 to 400 cows. One dairy (C, fig. 2) received installations of freshly treated cords impregnated in a 7.5-percent parathion

solution and air dried for 3 weeks before installation. The second and third dairies (T and Ra, fig. 2) received installations of freshly treated cords impregnated in a 7.5-percent and a 10-percent parathion solution, respectively. The 3-week-old cord installed in dairy C was used as a means of overcoming the 3-week period usually required to bring fly populations to control levels, a lag possibly caused by the repellency to flies of freshly treated cords.

Two areas (2 x 3 miles each) containing approximately 25 houses each were selected for the rural study. In one area, the individual premises were treated with cord impregnated in 7.5-percent parathion solution; the second area served as an untreated check. The 15 premises of highest fly potential in each area were selected for grill index determinations.

Two military dining halls of similar construction and area were selected for study. One dining hall received treatment with cord impregnated in a 7.5-percent parathion solution; the other was used as an untreated check.

Results

The results of the parathion cord treatment in dairies are shown in figure 2. Housefly populations at dairy C, which received a treatment with 7.5-percent parathion-impregnated cord air dried for 3 weeks, were sharply reduced to control levels the first week after treatment,

Figure 2. Control of houseflies in dairies with parathion-treated cords.

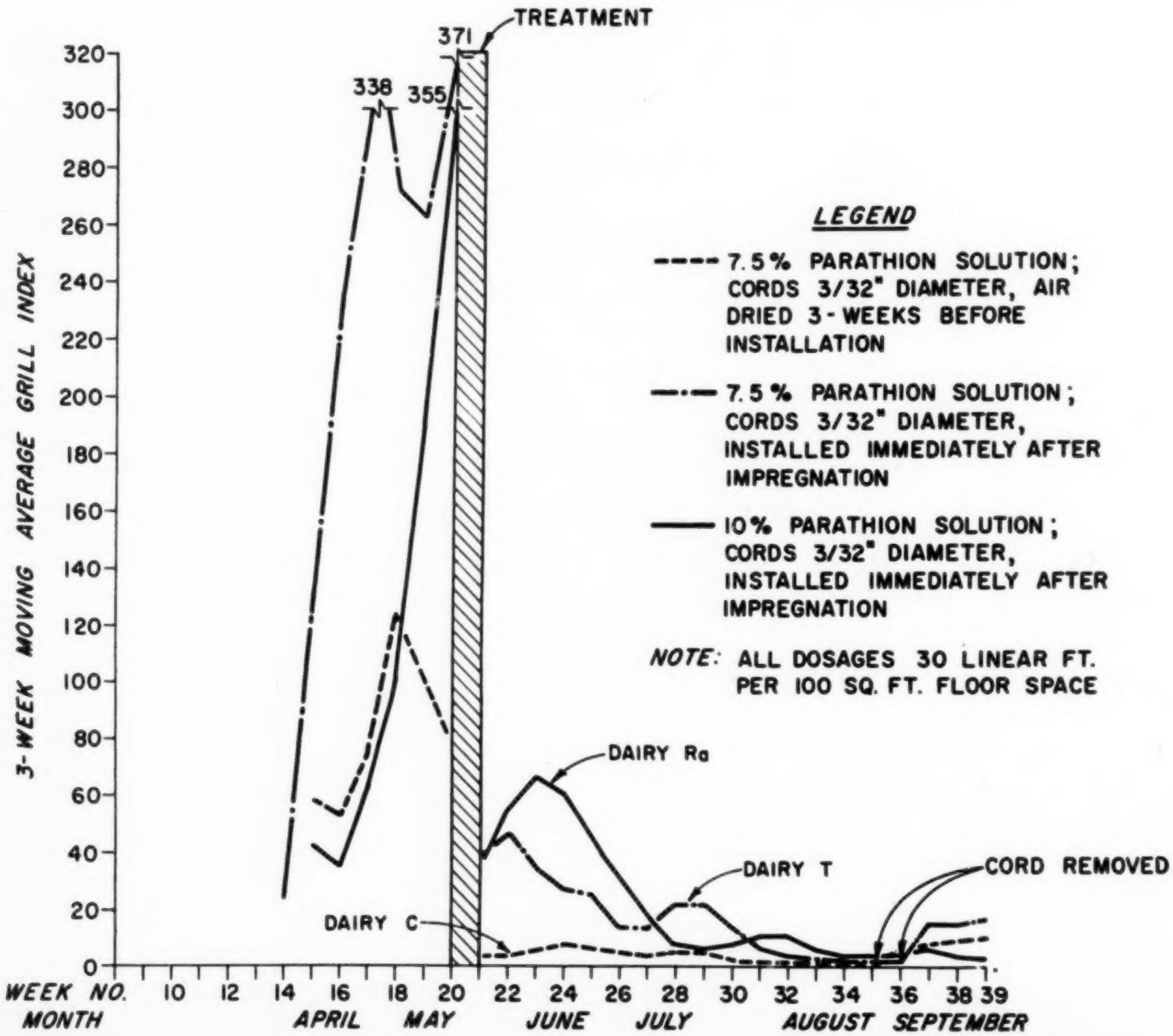
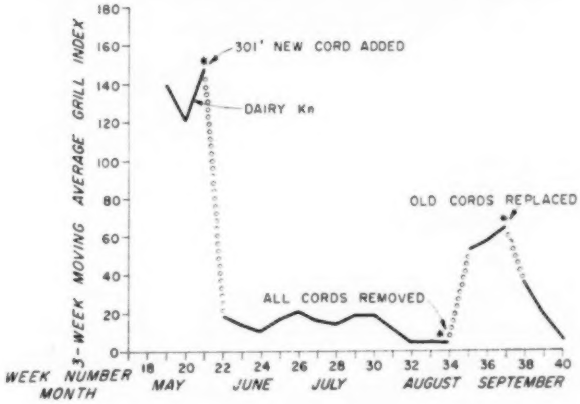


Figure 3. Control of houseflies in dairies with 12-month-old parathion-treated cords (1953).



and fly densities remained at very low levels throughout the entire season. The second dairy (T), treated with cord freshly dipped in a 7.5-percent parathion solution, showed an immediate reduction in the fly population, but control levels were not reached until several weeks after treatment. However, once control levels were obtained, low fly populations prevailed the remainder of the season. The third dairy (Ra), treated with cords freshly dipped in a 10-percent parathion solution, showed a gradual decline in fly densities which did not reach control levels until 7 weeks after treatment. This unsatisfactory slow drop in fly densities was due in part to a disruption of normal sanitation practices coincident with the treatment of the dairy. As a result, the pressure of fly production was abnormally high. After the usual practices of manure handling were reestablished, control levels were maintained.

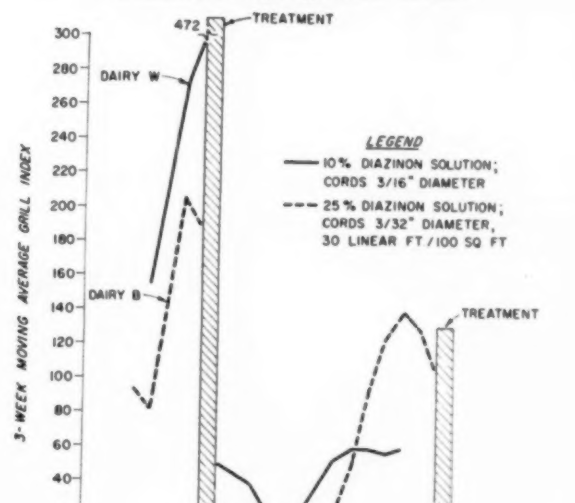
The effect of parathion-impregnated cords on fly populations is depicted most graphically in figure 3. In this dairy (Kn), parathion-treated cords $^3/_{16}$ inch in diameter installed the previous year were allowed to remain in the dairy establishment throughout the winter months. In addition, 300 feet of newly treated cord ($^3/_{16}$ inch in diameter) was installed in a recently built calf shed. Satisfactory control of flies ensued throughout the following summer. In August, all cords were removed from the barns and immediate increases in fly population levels were noted. In early September, the same cords were reinstalled and an immediate reduction of fly indexes to control levels was achieved.

The results with Diazinon-treated cords are shown in figure 4. In 1953, the dairy (B) treated with cords ($^3/_{16}$ inch in diameter) impregnated in a 10-percent Diazinon solution displayed substantial reductions of the housefly populations, with reduced indexes persisting for 3 to 4 weeks. In 1954, the same dairy treated with cord ($^3/_{32}$ inch in diameter) impregnated with a 25-percent Diazinon solution showed immediate reduction of housefly densities to control levels, and these low levels were sustained for 7 weeks. After this period a sharp increase in fly indexes occurred. In mid-August, retreatment with freshly impregnated cord again resulted in excellent housefly control for a period of 7 weeks.

In figure 5 are shown the comparative housefly population trends in treated and untreated rural areas. After installation of the parathion-treated cords, excellent fly control was obtained for the remainder of the season. In the untreated area, the reduced fly levels were caused by the use of poison baits by individual residents. However, fly population indexes were not lowered to the levels obtained in the zone treated with parathion-impregnated cords.

The results of installation of parathion-

Figure 4. Control of houseflies in dairies with Diazinon-impregnated cords.



treated cord in a military dining hall and kitchen (fig. 6) indicate excellent control of houseflies during the 10-week observation period. Total fly counts in the treated dining hall and kitchen ranged between 1 and 16 flies per inspection, whereas total counts in the untreated dining hall and kitchen ranged between 110 and 260 flies per inspection.

Discussion

The use of smaller cords ($\frac{3}{32}$ inch in diameter rather than $\frac{3}{16}$ inch in diameter) in 1954 was based on the similarity in the control performance of cords of both sizes in previous studies. In addition, the $\frac{3}{32}$ inch in diameter cord is cheaper and reduces the potential hazard to humans because of the lesser amount of parathion per unit length of cord (75–100 mg. vs. 150–250 mg.). It also permittted an increase in cord dosage per 100 square feet, thereby augmenting the toxic area available for fly contact without increasing the overall amount of parathion within a barn.

In general, the results of the 1954 tests and those of previous studies indicate that parathion is the most effective chemical tested for the treatment of cord for control of *Musca domestica* since it is the only impregnant to date which gives satisfactory control of insecticide-resistant houseflies for extended periods of 2–3 months. Indications are that air drying

Figure 5. Control of houseflies in rural areas with parathion-impregnated cords.

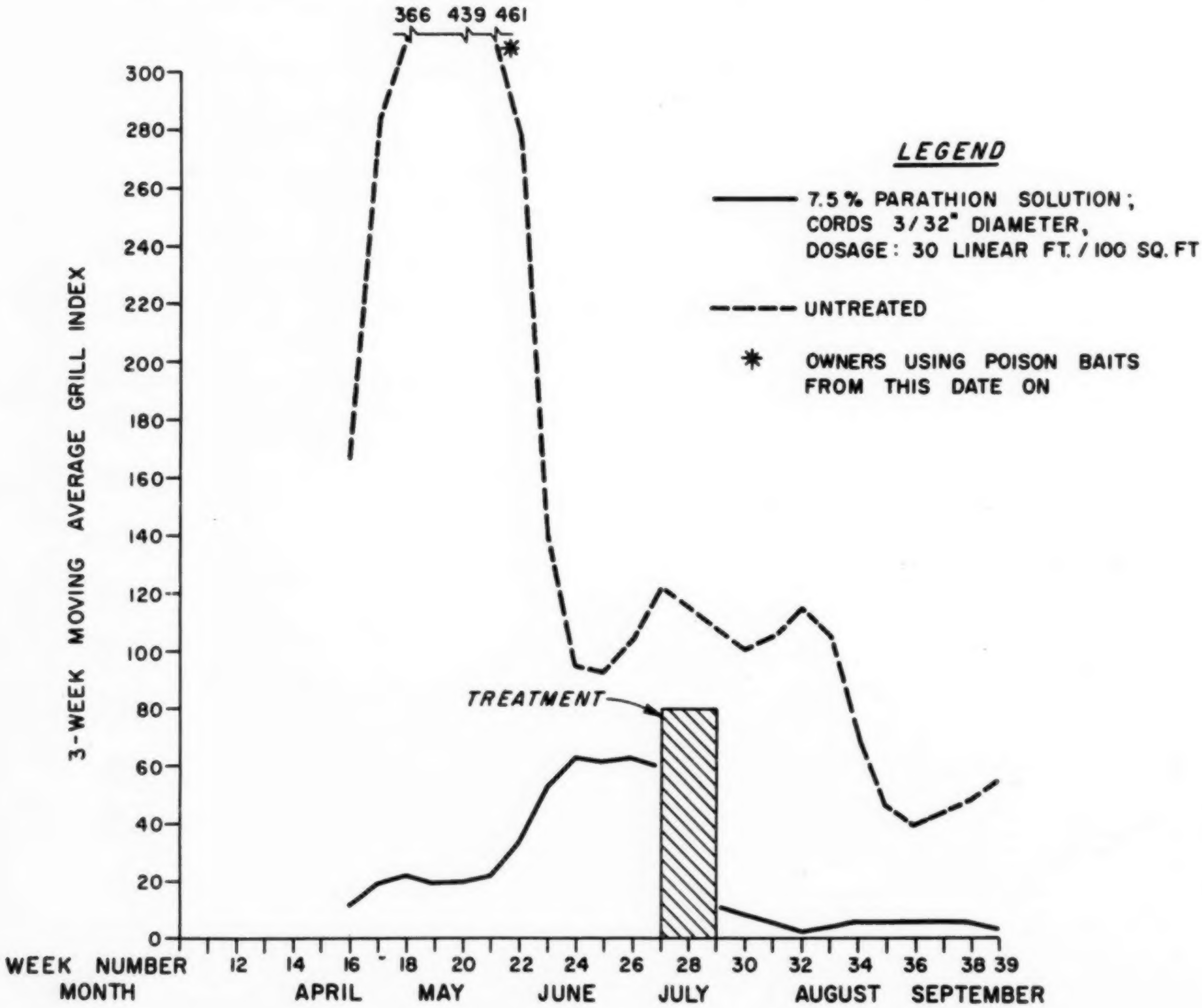
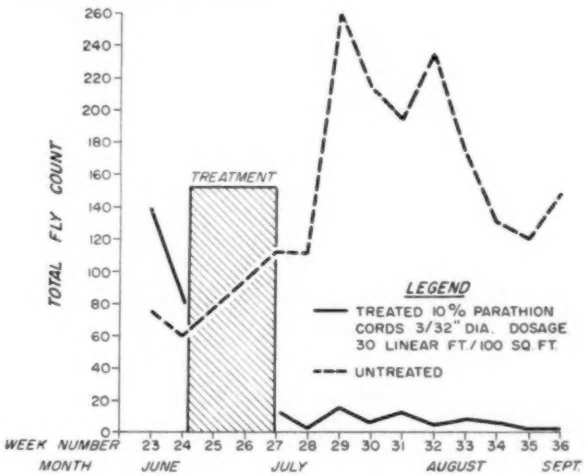


Figure 6. Control of houseflies in a military dining hall and kitchen with parathion-impregnated cords.



of the cords for a period of 3 weeks before installation tends to improve their initial efficiency. Assumptions are that during the 3-week air-drying process various fractional impurities of parathion dissipate, leaving a treated cord which apparently is less repellent to the flies. Although the dairy treated with parathion-treated cord, air dried for 3 weeks, gave the highest level of control, it should be noted that the pretreatment indexes at this dairy were much lower than at the other two dairies.

Diazinon-treated cords when impregnated by dipping in a 25-percent solution were extremely effective for periods of 7 weeks. The shorter residual activity of these cords as compared to parathion-treated cords may be compensated for under certain conditions by the lower toxic hazard to mammals.

Chemical evaluation of the parathion concentration in the air of several dairies and kitchens has indicated a level of only 0.02 microgram of parathion per liter of air. Routine checks on the cholinesterase levels of individuals preparing and handling treated cords have shown no significant change in these indexes nor have there been any reports of any toxic effects of the treatment upon the exposed human populations in the dining halls, kitchens, or dairies employed in the studies.

The commercial development of parathion-impregnated gauze in Denmark as reported by Wichmand (*14*) and its widespread use on farms in that country have demonstrated that parathion-treated gauze can be used safely and efficiently by the public in fly control. Under similar conditions of commercial preparation, parathion- and Diazinon-impregnated cords offer definite promise as a general fly control measure in the United States. Such cords should be properly identified by poison labels affixed at intervals of 5 feet. In view of the toxic hazards involved in impregnating the treated cord, it is not recommended that such cords be prepared by anyone other than commercial formulators.

Summary

Cotton cords $\frac{3}{32}$ inch in diameter, impregnated in 10-percent and in 7.5-percent parathion-xylene solution, have given seasonal control of insecticide-resistant housefly populations in dairy barns. Cords impregnated by immersion in a 25-percent Diazinon solution yielded 7 weeks' effective control. Cords treated with 7.5-percent parathion solutions provided excellent control of houseflies for more than 10 weeks in rural areas and for 10 weeks in a military dining hall and kitchen. Air samples in dairy barns and in kitchens of rural homes revealed only 0.02 microgram of parathion per liter of air. No significant changes in cholinesterase levels were noted in individuals processing or installing parathion- and Diazinon-treated cords.

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Diabetes Control Courses in Boston

Four courses in diabetes control will be given at the Public Health Service Diabetes Field Research and Training Unit, Boston, Mass., for physicians, public health administrators, nurses, dietitians and nutritionists, social workers, health educators, and medical technicians. The courses for 1956 are:

Patient education in diabetes, designed for those concerned with individual and group instruction of persons with diabetes and with the families of these patients, will be given from February 27 to March 2. It is recommended for teams of workers. Membership for this course is limited to 12.

Nursing aspects of a diabetes program, designed for nurses in official and nonofficial health agencies, general and special hospitals and other institutions, clinics, schools, and hospitals, will be given March 19–23. Enrollment is limited to 15.

The clinical and community approach to diabetes will be given April 23–27 and again October 1–5. Planned for professional workers interested in diabetes programs, membership is limited to 20. Priority is given to applications from teams of staff workers from one agency.

Nutritional aspects of a diabetes program, given May 21–25, is arranged for dietitians and nutritionists in public and private health agencies, clinics, hospitals, and other institutions. Membership is limited to 15.

There is no fee for registration or tuition. The classes run from 9:00 a. m. to 4:30 p. m. daily. Part-time or intermittent attendance is not accepted. Application for admission to any one course should be filed as early as possible. Information about hotel accommodations will be sent after application is received. Further inquiries should be addressed to: Diabetes Field Research Training, 639 Huntington Avenue, Boston 15, Mass.

Man's Emergence Toward Health

By HENRY VAN ZILE HYDE, M.D.

ONE of the signal honors of public health is an invitation to deliver the annual Winslow lecture. I am fully cognizant of this and deeply appreciative. All of us, I am sure, could tell of acts of friendship that have been extended to us by Professor Winslow and Mrs. Winslow, and we could tell, as well, of the stimulation and inspiration that we have gained from both of them. I had the good fortune to practice medicine in Syracuse, N. Y., a city known throughout public-healthdom as "A City Set on a Hill." I entered practice there shortly after Professor Winslow's book of that title was published, a book that revealed to me an exciting new area of interest and action, an interest which later became my career. So it is with a feeling of gratitude and warmest friendship, which has grown through the years, that I address you in honor of Dr. Winslow.

My title, "Man's Emergence Toward Health," may seem ambitious, but it grows from a feeling that builds up in one, unconsciously and quite inescapably, while traveling about the world in these days with an eye focused on health. We have tended to look at our business of public health as a small business, circumscribed by our own municipal environment, or, perhaps, our State or national environment, but since World War II public health has grown beyond these limits. There is a movement under way in health which constitutes one of the great facts of our time, a force that is shaping world events now and for the long future. We as public health workers must recognize this force in our own field, understand it, and guide it, for any great force loose in the world today can be used to build freedom or, on the other hand, to build tyranny.

Dr. Hyde, chief of the Division of International Health, Public Health Service, and United States member on the Executive Board of the World Health Organization, delivered the Winslow lecture at Yale University, March 28, 1955.

Universal Swing Toward Health

The story of the development of public health in northern Europe and in the United States is known to most of you. It is a story told by the public health historians and particularly well, of course, by Dr. Winslow. As historians and philosophers view the progress of man, some see it as a slow upward crawling interrupted by frequent backward slippings. Others see it as a series of explosions, each related to some new basic discovery such as fire, cultivation, domestication of animals, the discovery of iron, or the harnessing of atomic energy. The development of public health appears to take this latter form, an explosion which, indeed, is modeled on the ultramodern design of the mushroom cloud—in shape but not in effect. The vertical stem of the cloud is the explosion in time—public health history. It is a very, very short history as you know, occurring almost entirely within two, or at the most, three generations of public health leaders.

Short as is the vertical stem of the public health explosion, we are witnessing today the equally dramatic lateral expansion of the mushroom cloud. Prior to World War I, public health activity in great areas of the world, if extant at all, existed mainly for the protection of the colonizing forces, for the governors of men, not for man himself. Today, in contrast,

we see a profound and universal swing toward health for all men who people the world.

Evidence of man's explosive emergence toward health is seen in the current mass attack on communicable disease in the underdeveloped areas, in the widespread development of increasingly competent national health services, in the establishment of extensive networks of rural health centers and in the intensification of international action in the health field.

One of the most impressive and significant phenomena of our times is the mass control of certain diseases, even to the point of eradication in vast areas. The reality of this accomplishment strikes one with great impact on visiting the affected areas of the world; the scope of it is tremendous.

In 1948 the incidence of malaria was estimated at 300 million cases per year. Recently, the World Health Organization has announced that 243 million, or almost one-half of the 552 million people living in malarious areas, are now protected against malaria. In dealing with such figures we are speaking of one-fifth of the population of the entire world. In India 125 million of the 200 million persons exposed to malaria are now protected. Italy, Greece, Iran, Thailand, Ceylon, the Philippines, Formosa, Venezuela, and Brazil are among the countries that have taken similarly important strides in this field. The nations of the Western Hemisphere, not satisfied with mere control of this disease, decided in Santiago, Chile, in October 1954 to act in concert actually to eradicate malaria from the entire hemisphere, and it is anticipated that this astounding feat can be accomplished within the next 8 years. Likewise, a recent World Health Organization malaria conference held in the Philippines resolved that eradication, rather than control, must be the objective in Asia.

On a somewhat lesser scale, yaws, which is a particularly crippling and disfiguring chronic infection, presents a similar example of accomplishment in mass disease control. Within the last 6 years 35 million people have been examined for yaws, and 8 million have been treated. As recently as 1950, 50 percent of the total population of Haiti and an even higher percentage of its rural population suffered from

PHILIPPINES—A nurse from a rural health center visits a barrio under her jurisdiction. Her work and that of others like her is slowly replacing the work of the herbolarios and primitive jungle practitioners.

this disease whereas a recent survey following an intensive nationwide campaign showed only 0.03 percent of a sample rural population infected. Under the program presently being conducted in Indonesia, where there are an estimated 20 million persons infected with yaws, the target is 1 million examinations per month expected to reveal 83,000 clinical cases which will be given the required treatment.

The scope of the work that is under way is further attested to by the international program of vaccination against tuberculosis with BCG vaccine. Since 1947, while the experts have continued to debate the exact value of the vaccine, 101 million children, or approximately 10 percent of the world's children under 19 years of age, have been tested for tuberculin sensitivity, and 43 million of the negative reactors have been vaccinated.

Even in the face of such massive accomplishments, the expanding mushroom cloud of the health explosion would have little substance in the absence of a sound basic health structure. The availability of effectively organized and competently staffed national and local health services capable of thoughtful planning and able to reach the people is, of course, the essential ingredient of permanent accomplishment. Mass control of disease is pointless, except as a transient satisfaction, unless there are services available to maintain the achievement. Therefore, the element of greatest significance in the present movement—that which Dr. Winslow would consider most fundamental—is the widespread establishment of such services.

Organizational progress both centrally and at the community level is being made in many countries. Eight of the governments of the Western Hemisphere have elevated their health departments to the rank of cabinet ministries within the decade. These ministries, as well as the health departments that exist elsewhere, are being manned to an ever-increasing extent by well-trained personnel. During the past 12 years, at which time the Institute of Inter-American Affairs gave the lead in establishing international governmental fellowships, more than 1,700 fellowships have been awarded to Latin American professionals by the institute for study of various phases of public health in the United States. During the years 1947–54 the World Health Organization awarded 4,356 foreign fellowships on a worldwide basis.

The flow of foreign fellows being placed by the Public Health Service under a variety of programs for training in the United States is shown in table 1. This is, of course, additional to the fellowship programs of the private foundations and of governments themselves. In

Table 1. Foreign fellows programed by the Division of International Health, Public Health Service, 1951–55

Area	1951		1952		1953		1954		1955		Total
	United States programs [1]	WHO [2]	United States programs [1]	WHO [2]	United States programs [1]	WHO [2]	United States programs [1]	WHO [2]	United States programs [1]	WHO [2]	
Western Hemisphere	46	14	53	32	111	36	135	44	134	40	645
Europe	88	6	94	25	65	50	21	16	27	20	412
Near East, Africa, and Southeast Asia	23	10	85	17	95	21	81	16	98	10	456
Far East	93	10	154	28	274	31	288	27	247	30	1, 182
Total	250	40	386	102	545	138	525	103	506	100	2, 695

[1] Includes Mutual Security Administration, Technical Cooperation Administration, Institute for Inter-American Affairs, Foreign Operations Administration, European Cooperation Administration, International Cooperation Administration of the Department of State as well as programs under High Commissioner of Germany, Supreme Commander Allied Forces in the Pacific, Public Law 759, 81st Cong., 2d sess. (government and relief in occupied areas), Public Law 265, 81st Cong., 1st sess. (Finnish war debt), and Public Law 402, 80th Cong., 2d sess. (Smith-Mundt Act).

[2] The Public Health Service assists in programing only a part of the total number of WHO fellows in this country.

several of the countries, such as Brazil, Mexico, Chile, and Lebanon, training is being bolstered by new schools of public health that have been established or, as in the case of the Philippines and India, old ones that have been recently strengthened.

New and essential basic organizational units, such as divisions of public health nursing, environmental sanitation, sanitary engineering, health education, vital statistics, training, planning, and so forth, are being established within health departments and ministries. Twenty-three of thirty-seven of the less highly developed countries, for instance, today have a nurse serving in the ministry of health at the national level as shown below:

Nurse at national level: **Brazil, Chile, Colombia, Costa Rica, Dominican Republic, El Salvador, Formosa, Haiti, India, Indonesia, Iraq, Israel, Korea, Lebanon, Liberia, Mexico, Panama, Paraguay, Peru, Philippines, Thailand, Uruguay, Venezuela.**

No nurse at national level: **Afghanistan, Bolivia, Ecuador, Egypt, Ethiopia, Guatemala, Honduras, Indochina, Iran, Jordan, Libya, Nepal, Nicaragua, Pakistan.**

It is of particular significance that the first category includes a number of countries in which women were in deep purdah until very recently. The demonstrated value of nursing has over-ridden the prejudices and attitudes of many ages.

As part of the development of more effective services, there is a movement toward the progressive decentralization and expansion of health administrations, bringing them into closer relationships with the people they are designed to serve. Such movements are particularly conspicuous at the moment in Iran, Iraq, the Philippines, Brazil, and Mexico. Rather extensive formalized plans covering various periods, usually 5 years, are under way in a

Table 2. Rural health centers in certain countries

Country	Population [1]	Type and number of centers
Thailand	20, 000, 000	720 rural health centers. 91 first class (physician, nurse, etc.). 629 second class (sanitary inspector, midwife).
Egypt	21, 935, 000	153 rural health centers. 151 rural social centers with health services. 80 child welfare centers with health services.
Philippines	21, 440, 000	956 rural health units (all types, various stages of staffing). 81 demonstration rural health units of United States type.
Indonesia	78, 163, 700	2,432 government polyclinics. 234 private polyclinics.
Pakistan	75, 842, 165	188 rural health centers.
Taiwan	8, 617, 000	344 rural health stations. 22 county health centers.
Haiti	3, 227, 000	3 rural health centers.
Iran	20, 253, 000	3 large mobile health units (Caspian region, Teheran, Tabriz). 8 completely equipped demonstration health centers from which operate 25 small mobile units.
India	372, 000, 000	5,840 rural dispensaries.[2] 1,695 urban dispensaries.[2]
Brazil	57, 098, 000	1,950 official public health services: 1,280 general. 670 specialized.
Colombia	12, 108, 000	103 health centers (physicians, nurses, etc.). 306 health stations (sanitary inspector). 15 mobile units.
Mexico	28, 850, 000	1,277 rural health services: 528 centers of hygiene and medical care 463 clinics of medical service 163 dispensaries 103 first-aid stations 20 vaccination offices.
Uruguay	2, 525, 000	123 polyclinics. 18 departmental clinics. 29 auxiliary clinics.

[1] From United Nations Statistical Yearbook, 1954. [2] Provided for in 1955–56 plan.

PHILIPPINES—A rural health specialist points to a demonstration area where Philippine personnel are being trained for service to families residing in remote areas of the islands.

number of countries—either as separate health plans, as in the case of the $75 million 5-year health plan in Iraq, or as a major segment of a general development plan, as is the case in Iran, India, and Pakistan.

The far-reaching character of the present movement in health is evidenced best by the rapid expansion of networks of urban and rural health centers which are penetrating remote areas and blanketing much of the world. While providing varying degrees of medical care, which they must in the areas in which they operate, they are increasingly providing preventive services with trained auxiliaries assisting the professional personnel. Quite surprisingly, it is not possible to find and present any substantial data on this dramatic development; even the nomenclature is muddy. There is in this a serious gap in our knowledge that needs to be closed. The spotty information that can be found is presented in table 2. Increasingly, such centers are becoming integrated into total community development programs, which encompass services designed to improve agriculture, education, and the total village economic and social structure. At the moment this desirable trend is conspicuous, particularly in Mexico, Egypt, and India.

International cooperation, as a field of action, presents dramatic evidence of the momentum of the health movement on a world basis. Before World War II there was limited activity in international health carried on by the International Office of Public Health in Paris, the Pan American Sanitary Bureau in this hemisphere, and the League of Nations health section, the work of these organizations being, at that time, restricted almost entirely to the international exchange of epidemiological information.

However, the League of Nations did embark, in a small way but with great vision, on programs for the development of international standards for drugs and biologicals, the improvement of health statistics, the development of standards of human nutrition, and the provision of technical assistance to governments in the development of their own health services. Through its survey and advisory health missions to Greece, China, Bolivia, and other countries, it became the pioneer in the field of international technical assistance which has expanded so greatly in many fields since World War II.

Emergence of WHO

From these origins sprang the World Health Organization. It is not the world equivalent of the health department located in the cellar of the county building. From the standpoint of membership of sovereign nations, the World Health Organization is the largest official international structure ever built by man, with a membership of 80 states as compared with the United Nations, for instance, which has a membership of 60 states. Staffwise, with 1,307 employees, it is the largest agency within the United Nations orbit, except for the United Nations itself. On the world scene, therefore, health is, today, one of the "big shots" of intergovernmental action. This represents explosive progress.

The health budget of the League of Nations never exceeded $400,000, of which only $200,000 was contributed by governments. During the interwar period the total annual governmental

HAITI—Yaws patients wait for treatment at a clinic.

contribution to international health work, including contributions to the International Office of Public Health in Paris and the Pan American Sanitary Bureau, never reached $300,000, with the United States, which was not a member of the League, contributing only $6,000 to the world program and $60,000 to the hemispheric one each year.

This provides some measure of the extent of governmental interest in health so short a time ago. In contrast, the World Health Organization budget, financed entirely by contributions from governments, is now at the level of $10 million. In addition, WHO gives leadership and direction to health programs it undertakes jointly with the United Nations Children's Fund and the United Nations Technical Assistance Program. Its total annual resources, direct and indirect, are, therefore, in the neighborhood of $15 million.

Governments established the World Health Organization because of their recognition of the need for international cooperation and assistance in health, yet, in 1948, when the World Health Organization stepped onto the world stage and offered technical services to governments, there were few takers. Most governments wanted supplies and nothing less tangible. The scene has changed rapidly with the growth of understanding, and today the World Health Organization has technicians in almost every country in the free world. In 1954 alone, it was engaged in 329 major projects in 75 countries. Its most pressing problem is that of meeting from its available resources the requests that flow in.

The World Health Organization activities represent common action through international pooling of resources and skills. The United States is supplementing these activities by conducting a cooperative international technical assistance program in health, which is administered by the Foreign Operations Administration with the support of the Public Health Service, the universities, and other private agencies. (On July 1, 1955, the Foreign Operations Administration was abolished, and its technical assistance activities taken over by the International Cooperation Administration of the Department of State.) This is the program widely known at one time as point 4, which has a health component operating at a level of $26 million per year. Taking this into account, the total contribution of the United States to international health work, made directly and through the international agencies, now ranges around $40 million. This is a far cry from the $66,000 of only 10 years ago.

The Demand for Better Health

Recognizing that there has been a great acceleration in the tempo of health development, one wonders what the underlying factors are that have brought it about. The fundamental factor is a demand from the masses for better health, growing from the demonstration that health can be obtained at a reasonable cost through techniques now available. The realization that ill health is avoidable has penetrated to the remotest areas, creating a political force of local, national, and international significance.

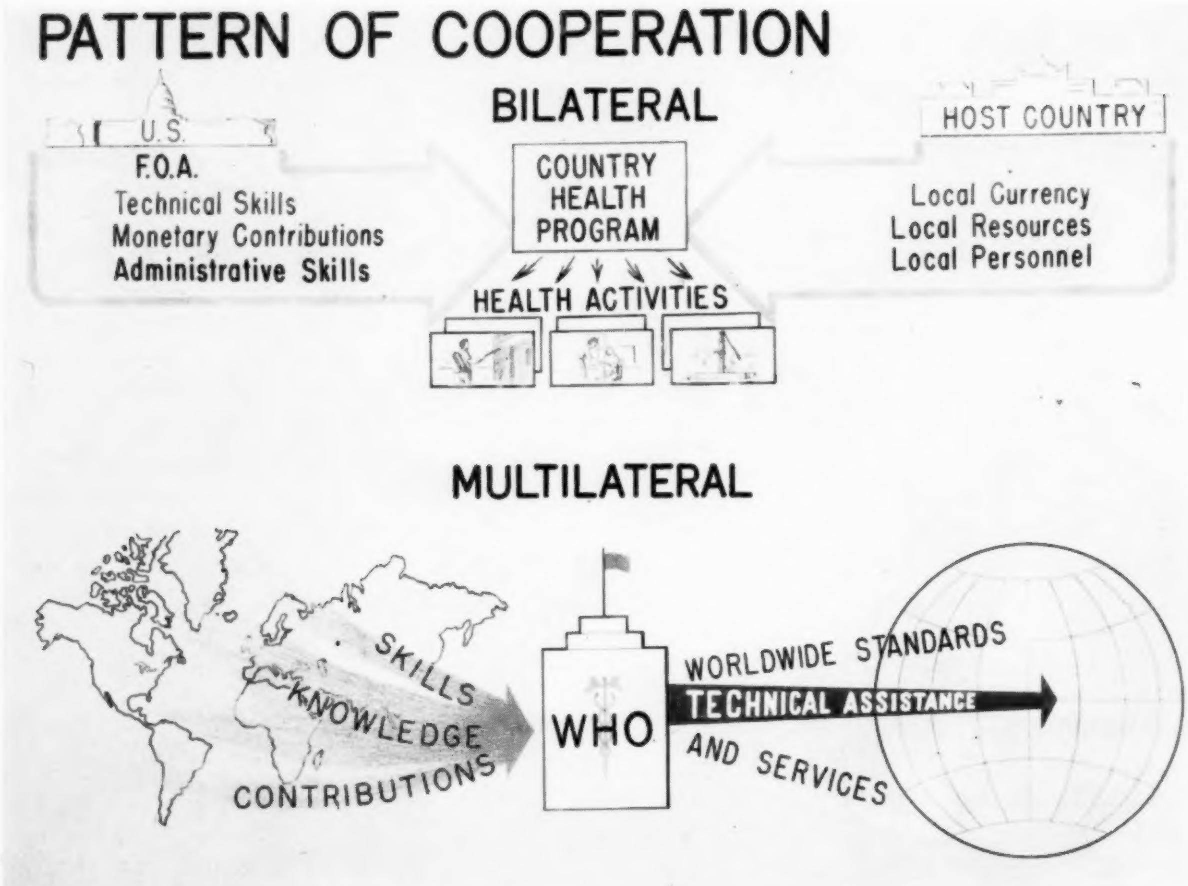
The demand for health is based fundamentally, of course, on the innate animal desire for relief from pain and suffering and the equally innate instinct to protect one's offspring. Through the milleniums, efforts to modify pain and suffering have been made through sacrifices to many gods, through attempts at avoidance by haruspicy, through incantations and the taking of strange mixtures. None of these efforts had a consistent

effect. It has been clearly demonstrated, however, in the relatively recent era of scientific public health that widespread and oppressive diseases can be controlled in a predictable way. The miracles of immunology and sanitation have been followed by those of DDT and penicillin. These have occurred concurrently with the widespread development of communication and transport, which has spread the message widely.

The extent to which news penetrates to remote places is perhaps not generally understood. The blaring of a public radio in the town square or at the main crossroad has become characteristic in poor and primitive population centers. It is not necessary to be literate, or to be able to afford a radio set or even the day's paper in order to keep in direct touch with world affairs. Further, remote areas are being opened up through the extension of farm-to-market roads and through the routine use of air transportation. The airplane has knitted together the scattered and isolated towns in such mountainous countries as Honduras and Colombia. President Tubman of Liberia now carries government, for the first time, into the remote bush through personal visits in a light plane. The Indian Health Service of Canada utilizes the airplane to provide regular service in the vast tracts of the north. This new nearness of man to the foci of progress has fed the desire for better health.

Since any desire shared by a significant number of people constitutes a political force, it is apparent that the widespread urge for health manifest today is a highly potent political force demanding action. Its intensity is heightened in countries that have recently attained independence because self-rule is associated in men's minds with a good life. Why, otherwise, fight for it?

THAILAND—Assistant director of a malaria control unit demonstrates mechanism of spray guns.



Such different men as Magsaysay, Nehru, U Nu, Mohammed Ali, Soekarno, and Kotelawala, who in common are leaders in newly independent countries, have initiated extensive national activity in health in a conscious effort to satisfy this expectation. Others, new in power, in countries with a long tradition of independence, such as Pibul Songgram in Thailand and Paz Estenssoro in Bolivia, have likewise stepped up health activities with a view to achieving stability and combating subversion. The communists utilize this same force in order to accomplish their ends. John Ridley, who accompanied Clement Attlee on his visit to Red China, has reported at some length in the *New York Times Magazine* (August 29, 1954) on the manner in which health is being employed to strengthen the hand of the present government there.

Internationally, the same political factor is at work. Here it is a matter of the cumulative force of the health demands of the total of the world's population. As the antipodal forces of freedom and tyranny clash on the world scene, each is trying to gain the adherence of the masses and using either health promises or performance as one means of doing so. We, for our part, have promoted and supported health measures through the World Health Organization, the Pan American Sanitary Bureau, the United Nations Children's Fund, the International Cooperation Administration, and the Colombo Plan for Cooperative Economic Development in South and Southeast Asia. On the other side, it has been largely a matter of false promises.

It is a generally accepted tenet of modern political philosophy that peace can survive only in the presence of economic growth and stability. There is increasing acceptance of the additional fact that a sound economy cannot be built upon a sick population. Professor Winslow has made a major contribution to this area of thought in his monograph on "The Cost of Sickness and the Price of Health," which was published in 1951 by the World Health Organization, and which has had wide influence

here and abroad. The relationship of health to economic development, which has been so clearly set forth by Professor Winslow and dramatized particularly by the modern story of malaria, has attracted the thoughtful attention of those who shape world affairs and has given health work much of its present momentum.

A lesser factor contributing strength to the international movement in health is the fact that protection against exotic disease in the face of modern transportation speeds has required a positive approach rather than the negativism of traditional quarantine. This positive approach has taken the form of international assistance in the control of disease at its source. In his account of Mr. Barr and the innocent introduction of smallpox into the United States, Dr. James S. Simmons has given us in "Public Health in the World Today" a compelling story of the need for this approach.

As contrasted to narrow nationalism, the growing recognition of the world as an essential whole provides the milieu within which health action spreads rapidly and widely without too great reference to artificial boundaries. Interrelatedness has replaced isolation, and there is a true sense of mutual responsibility for the state of the world at large.

In the free world, this sense of mutual responsibility is not motivated by political or economic opportunism alone. Much deeper and more meaningful forces underlie today's internationalism. The moral concepts that have shaped our own American freedom are known throughout the world and are inspiring today's movements toward freedom. The Declaration of Independence is not solely a United States document but a world platform; Lincoln is not a local figure but a world hero and a universal symbol of faith and hope. We can easily recall how the Atlantic Charter and its four freedoms electrified us only a few years ago. We wish to make good on those promises.

We cannot indeed sidestep moral responsibility for preventing disease because we know, with Thucydides, that "the true author of the subjugation of a people is not so much the immediate agent, as the power which permits it, having the means to prevent it." And we are the ones who have the means to prevent disease.

The moral drive underlying international action does not stem solely from political philosophies or from guilt but from a deeper root that underlies philosophy and guilt. It is perhaps a fortunate thing that the power and the wealth and a large measure of the greatly needed technical skills are in the hands of those whose religion drives them to share their substance. The medical missionary is a forerunner in spirit, more than in technique, of the official international programs in health.

Where can we derive more immediate satisfaction of our moral urge than in the field of health, sharing our resources in order to solve the massive immediate human problem touching every man? Freeing man from the burden of disease so that he might have flight of spirit satisfies the requirements of today's moral urge as well as any immediate material goal. Whether programs are labeled health, agriculture, economic development, or technical assistance, the improvement of man's daily life is their goal, and, directly or indirectly, they must bear upon man's health.

All of this is of particular importance to us as workers in public health. We cannot think of peace as a problem solely for the diplomat or the statesman, nor of economic development as a problem for the economist alone. The emergence of man toward health constitutes a fact of our times within our own sphere of responsibility that is very truly affecting the future of mankind. India will never again be what it was yesterday, nor will Brazil, nor Mexico, nor Haiti, nor Indonesia, nor any country in the so-called underdeveloped belt.

We, as professionals in the field of health, have the primary responsibility for assuring that this great force, which is expressing itself with explosive rapidity, is utilized to the fullest extent in the furtherance of freedom and the establishment of peace. It is encumbent upon us not only to recognize it but to understand it much more deeply than we do today. As in the case of any great force, it can be used well or badly for good or for evil. Its proper use is our particular and inescapable world responsibility. May we discharge it wisely and for the betterment of all mankind.

Public Health in Pennsylvania

By BERWYN F. MATTISON, M.D.

OUR changing attack on disease is necessitated by changing community disease patterns. To provide new and extended forms of health protection for the people of Pennsylvania, we have asked for support of services of proved efficacy and for limited demonstrations to provide effective health protection techniques where none are now available. Without that support, the people will die needlessly.

A Purchasable Commodity

It has been said that "public health is purchasable," and that statement is still true. If those who might be tempted to "economize" on health could but know the human details of the resultant personal misery, they would hesitate no longer. This understanding is no matter for statistics. Even words are inadequate!

To appreciate the real value of what we do in public health one must experience the moments of anguish, as so many physicians and nurses present today have, when a mother is told that her tiny daughter, born a few hours or days prematurely, has not survived—and know, within his heart, that with very special care, she might have lived. Or, one must have had the responsibility of telling parents that their apparently healthy boy has epilepsy and feel keenly that much could be done for him that may never be done.

I have seen an otherwise attractive little 9-year-old girl hiding behind a packing box and peering wistfully out at other children because her unrepaired harelip was a thing of laughter and ridicule among them. Yet, Pennsylvania has one of the best programs in the Nation for that kind of care. I have looked into the eyes of a still feverish child who was running and playing a week ago and evaded the answer to her unspoken question as she tried to move a leg made limp by poliomyelitis and wondered if our present local health services are geared to assure every child in the State the new protection available.

How many of us have cared for cancer patients—heard them tell of their families and their plans for the future—when we knew full well that, through lack of information, or diagnostic facilities, or willingness to accept early treatment, they had already traded a probable cure for certain tragedy? Not only statistics but a sense of personal values should indicate universal support for our programs.

The estimated number of Pennsylvanians suffering from chronic alcoholism is staggering. The dollar loss to industry, year after year, is appalling. But the real enormity of the problem only hits us when we think of our friend and neighbor, Joe Doaks, who had a good job, a home, and a happy marriage with two fine children. Before help was provided, he had lost his job, his home, and the respect of his wife and children. The look in those children's

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Dr. Mattison, secretary of health of the Commonwealth of Pennsylvania, presented this paper at Pennsylvania's Fourth Annual Health Conference, held August 16, 1955, at University Park, Pa. In Pennsylvania, the health conference pattern provides for full participation of four autonomous groups: the Pennsylvania Department of Health, the Health Council, the Medical Society, and the Public Health Association.

eyes, the tone of their voice when they mention their father—these are not statistics. They transcend cold, hard facts and figures.

The young man who didn't complete his schooling because, a generation ago, his father died of tuberculosis has finally worked up to a decent job, has married and had his first boy, and is now told that he, too, has tuberculosis. But, it is early and minimal, because it was picked up by a mass survey before he became ill. A fine hospital with excellent medical care is freely available to him. A public health nurse will help his physician check his family and will help carry out a home care regimen prescribed by his physician after a shortened hospital stay. We know, and he knows, that his chances of returning to his family and his job within a reasonable length of time are excellent.

These are the human values we are dealing with day in and day out. Let us not move so far away from them that we, or any one else, will be allowed to think of public health only in terms of statistics or dollars.

Applied Principles

The principles we are applying in a stepped-up program of health protection for Pennsylvania are many.

First, we accept the fact that optimum communitywide prevention of disease is not a one-man or a one-agency affair. Three links are needed to forge the chain, each one equally vital: the individual, who must be given the knowledge of, and willingness to accept, what modern medicine can offer him; the private physician, the first line of defense against many diseases, who should provide community leadership in all health programs; and the health agencies, official and voluntary, which can do those things not possible individually but effective on a group or community basis. It has been used so much that I hesitate to label public health a "team" affair. But, with the complexity of our social and industrial structure and with the variety and costliness of health protective techniques now available, it most certainly requires the best efforts of all—working together as closely as we can—to do the most nearly complete job.

Second, we have accepted the increasingly important role played by health education in today's public health practice. Health education stands in the same paramount position now as sanitation did 50 years ago. It presents our best weapon against the chronic diseases now most prevalent, just as sanitary measures provide a continuing bulwark against the gastrointestinal diseases.

Our task is not simple, for information is not enough. We must learn how to break down "sins" which beset us all—lethargy, rationalization, and misinformation. Probably no area of discussion, not even the weather, has been so long and thoroughly explored as our physical and emotional ills. Yet we have only to consider the folklore which has been built up around one disease, poliomyelitis, to highlight our difficulty. Much misinformation must be dispelled, much wishful thinking replaced by openmindedness, before we can begin to arouse folks from their complacency and stimulate useful action. This will take time, training, and tenacity.

Third, we accept the proposition now repeatedly proved across the land that health services as nearly indigenous as possible are the most effective. Pennsylvania has, and always should have, broad responsibilities to see that the health of its people is protected. It will probably always be far more economical and efficient to have a central staff of experts in the various health fields to prepare standards and devise general programs.

But only as counties and health districts begin to participate in both supporting and providing the services they need to protect their health will those services be best tailored to each community's needs and be best accepted by its residents.

Only two counties have used the 1951 permissive legislation to establish local health departments. Many more are seriously exploring the possibility. What do county departments of health offer these areas now considering this extension of health protection? They offer more local determination of service priorities based on greater sensitivity to local needs; qualified medical leadership in public health, which in turn means closer coordination with

the clinical practitioners and increased interest on their part in preventive medicine; a broader tax base for the support of health services; and more readily available local services, whether they be nursing, immunization, sanitation, or health education.

As county departments spread across the State, many of the direct service functions now provided out of Harrisburg can be cut down proportionately. Supervision and correlation will, of course, be continued through district and regional offices.

Fourth, we accept the need for continually evaluating our programs. This is not easy, and we are inclined to give the concept lipservice rather than to work out real evaluations. There are at least three levels on which a program can be tested for its worth: the degree to which it meets a short-range, immediate objective such as reduction in complaints after correction of an overflowing septic tank; or the degree to which the program complies with established standards of acceptable performance such as the percentage of employees in a department having permanent merit system status; or finally, the degree to which a program can be associated in a cause and effect relationship with decreased morbidity and mortality rates. But whether our program tests are at the proximate, intermediate, or ultimate levels, some tests must be made, and year by year they must be improved. One of the immediate tests we might apply is to check our services against the health indexes of the people served.

We can observe vast differences in these health indexes. For example, our best 3 cities, as far as infant deaths are concerned, have an average infant death rate of 3.1 per 1,000 live births, but our poorest 3 cities have an average death rate of 14.6. This means that for every 15 baby deaths in one kind of community the other community has only 3. Are we putting in proportionately greater efforts to reduce the latter toll? Our best 5 cities have an average tuberculosis death rate of 2.6 per 100,000 population, but in our worst 5 cities we have an average rate of 20.3. So, for every 20 tuberculosis deaths in one kind of community there are less than 3 in the other. Our intensified efforts should be focused on the area with the greater need.

With these principles in mind, teamwork, health education, local autonomy, and evaluation; with adequate financial support from our appropriating bodies; and with the continued selfless dedication to the cause of better community health on the part of every one of us, we will together decrease each year the number of those among us who have been dying needlessly.

Mental Health Admissions

There were more than twice as many first admissions as discharges at public mental hospitals in 1954, according to the National Institute of Mental Health, Public Health Service.

New cases numbered 12,485, or 8 per 100,000 population, while 5,815 patients were discharged and 1,026 readmitted. The average daily patient load, including epileptics as well as mental cases, was 138,595, with 109,931 classed as mental defectives. The range of expenditures for patient care varied considerably among the States, but the average cost per patient-year was $1,039. Of the 157,770 patients on the hospital books at the end of the year, 139,977 were listed as in residence.

Data compiled by the National Institute of Mental Health for 1955 will appear in the forthcoming issue of *Public Health Reports*.

Epidemiological Tests of Theories on Lung Cancer Etiology

By WILLIAM HAENSZEL

QUESTIONS on the etiologies of lung cancer cannot be resolved by a single, decisive experiment or set of observations, and a single study is not the natural unit for discussing the epidemiology of this disease. The major concern must be with the interrelationships of findings and their collation to see whether a chain of evidence stronger than any single component part can be forged. Information on a proposed etiology cannot be assessed without relating it to both positive and negative findings on alternate possibilities, drawn from animal experimentation and other laboratory work as well as from epidemiological studies. Also, with a subject under such active scrutiny as lung cancer, it is difficult to attempt to divorce facts already established from interpretations which may either be stated explicitly or merely be implied by investigators through their choice of specific studies to be pursued. Under these conditions, a better perspective on epidemiological issues in lung cancer studies may be gained by viewing them in the perspective of possible future work. Since interrelationships of individual findings are the main concern, this paper deals more with the ideas underlying a set of studies than with the tactical details of any single study.

Mr. Haenszel is head of the Biometry Section, Biometry and Epidemiology Branch, National Cancer Institute, Public Health Service. He presented this paper at a joint session of the Biometrics Society and the Institute of Mathematical Statistics, Chapel Hill, N. C., April 23, 1955

Increase in Lung Cancer

If no real increase in lung cancer existed, all associations between lung cancer and exposure to atmospheric pollution, cigarette smoking, or other exogenous agents recently introduced into the environment would be suspect as not pointing to possible etiological relationships. A few persons still maintain that the recorded increase in lung cancer incidence and mortality is fictitious and has resulted from improved diagnosis (*1*), but this is no longer a popular position (*2*). Among the reasons for accepting a real increase in lung cancer mortality are the sex differences in rate of increase and the magnitude of the current, continuing increase (*3*).

One purpose for inquiries on the increase in risk would be to provide more precise quantitative estimates than are now available from mortality data which may later prove useful for reconciliation with numerical measures of exposure to suspected agents. For this reason, anyone proposing to study the effect of possible misdiagnosis of lung cancer as tuberculosis (*4*) or some other cause should relate these effects to data produced by the death registration system. Samples of deaths from lung cancer and other causes taken from vital statistics sources could be compared with autopsy protocols and other diagnostic evidence. Evaluation of the

two sources of error in official statistics, (*a*) deaths from other causes erroneously recorded as lung cancer and (*b*) lung cancer deaths attributed to other causes, would be rendered difficult by the selective character of autopsy statistics. However, the effort should be made. A useful minimum objective would be to determine how many lung cancer cases remain undiagnosed at present. Farber reported that in a series of 1,070 morphologically proved cases of bronchogenic carcinoma, 61 percent were not positively diagnosed prior to autopsy (*5*). Undoubtedly, many of these deaths were not recorded as lung cancer on the death certificate.

Environmental Agents

The working hypothesis for most investigators has been that the probable causes of lung cancer are to be found among environmental agents (*2*). The association of the high prevalence of cancers for several other sites, particularly the mouth, with specific customs found only in certain parts of the world strengthens the belief that direct contact with known or suspected carcinogens may be involved (*6*). On the assumption that agents with opportunity for direct contact with lung tissue are the most likely candidates, efforts to establish etiological relationships between lung cancer and environmental agents have been directed into three main areas: (*a*) airborne agents encountered in special occupations; (*b*) atmospheric pollutants, particularly those resulting from combustion of hydrocarbons; and (*c*) smoking of tobacco.

To assert that an agent is etiologically related to lung cancer simply implies that its removal from a defined population will result ultimately in a marked reduction of lung cancer. The population must be defined in a manner which safeguards against an effect being produced merely by the process of selection and classification. The concept does not require detailed specification of a mechanism producing the effect. Goldberger's finding that pellagra may be prevented by diet was no less valid because subsequent work led to the identification of the vitamin B complex and, finally, to nicotinic acid as the effective agent. This statement does not imply that ideas on mechanisms are not helpful; to the contrary, they may suggest situations in which data can be collected and tested.

Occupational Carcinogens

There is general agreement on the etiological significance of several occupational exposures, and such findings have been important in establishing the principle of multiple etiologies for lung cancer. Long-term observations of closed populations have convinced most people that the Schneeberg and Joachimsthal miners (*7*, *8*) and certain groups of chromate workers (*9*, *10*) were subjected, by virtue of their occupations, to excessive lung cancer risks. The evidence on chromate workers is purely epidemiological, not confirmed by animal experimentation, and was first suspected on the basis of clinical observations. Although many investigators have deduced from the Schneeberg and Joachimsthal observations that radiations emitted from radon were responsible, Lorenz felt that the case had not been firmly established and that other possibilities, such as dust pneumoconiosis, had not been conclusively ruled out (*11*).

Excess lung cancer risks detected by examination of occupational mortality data, such as data on workers employed in the preparation of coal tar products and producer gas (*12*), have also been generally accepted as reflecting an etiological relationship between lung cancer and some suspected carcinogenic agent in these products. Nor is there any great disposition to question the status of agents detected by clinical observations and retrospective studies of agents such as arsenic dust, nickel carbonyl, asbestos dust, and coke oven fumes (*13*). When the study results are reviewed to pick up occupational exposures which appear repeatedly, the danger of being misled by a highly unusual result in a single study is minimized. Additional occupational risks will no doubt be demonstrated in the future. However, because of the small numbers of workers exposed, the further denumeration of very restricted types of risks will not be crucial in working out the epidemiological details of lung cancer. This statement would not apply to the common and widespread agents contributing to atmospheric pollution, including hydrocarbon combustion products

such as industrial and heating plant wastes and motor vehicle exhausts.

Atmospheric Pollutants

To date, atmospheric pollution theories have not been well documented by demonstrations of excess risk among workers with heavy exposures to common atmospheric pollutants such as may exist in railroad yards, oil refineries, and congested urban areas. With the advent of group insurance and pension plans, the methodological problems of such inquiries have become much simpler. Several cohorts can be located for study. The National Cancer Institute is following a group of 1,100,000 railroad employees who have been in the industry 10 years or longer, including station, office, yard, and shop employees, as well as train crews. Rather detailed occupational histories are available and, with the accumulation of mortality data over several years, such specific points as the effects of dieselization, prolonged exposure to smoke in railroad tunnels, and metal dust exposures in shops may be looked into. The important feature is that work histories and exposures be specified in some detail. Significant effects may be diluted and overlooked by considering only gross company or industry experience.

The widespread use of petroleum products makes it very desirable to gather data on workers in that industry. Some medical departments of the major oil companies have staffs well equipped to undertake such studies. The major problem here, as elsewhere, is to secure access to company records and to rearrange data organized to meet other administrative needs. In areas where petroleum operations are concentrated, data might be collected on a geographic rather than an industrywide basis. At least one study is under way in Oklahoma which may yield some information on lung cancer risks among oil industry employees.

Those advancing atmospheric carcinogen theories have pointed to the sizable urban-rural differentials in lung cancer risk (*14*), although some further assumptions are required to reconcile this hypothesis with the great excess risk observed among males. The presence of carcinogenic substances in urban atmospheres has been repeatedly demonstrated by experiments with mice (*15*, *16*). Further epidemiological work has been hampered by the inability to classify individuals in the general population quantitatively with respect to atmospheric exposures. Meaningful histories are hard to collect, and in mobile populations, problems of classification by residence histories become complex. When leads on specific types of atmospheric pollutants are obtained from studies of special situations, the way may then be opened for return to the problem of reclassifying the general population with respect to special exposures with greater chance for success.

Smoking of Tobacco

Although at least 14 retrospective clinical studies (*17*) have reported on the association of smoking and lung cancer, these studies have been criticized on a variety of technical grounds. The objections advanced cover such points as interviewer bias (interviewers in some studies knew the identity of lung cancer patients and controls at the time of interview), and bias arising from selection factors associated with hospital admission (in most studies only hospitalized lung cancer patients were interviewed). However, the objection based on knowledge of the identity of patients and controls ignores the evidence of Doll and Hill (*18*) that males erroneously interviewed as lung cancer cases, as established by later events, showed smoking histories characteristic of the control rather than of the lung cancer series. Because of possible selection factors involved in taking up the smoking habit, some feel that the tobacco-lung cancer associations reflect associations with other common, but still unidentified factors.

The present data on associations between smoking and lung cancer are the most extensive and afford the most opportunities for discussing additional studies. For orientation, the type of evidence now on hand may be compared with the epidemiological findings for cholera, pellagra, and dental caries, all diseases in which animal experimentation played a minor role, at least in the early phases of the investigation (*19–25*).

On review, the basic core of associations on smoking and lung cancer must appear as impressive as any produced in these other investi-

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gations. However, lung cancer does not present the features of geographic localization characteristic for cholera, pellagra, and the absence of dental caries, which made it possible to elaborate in a rather straightforward manner the basic associations with water supplies suspected of contamination (cholera), diet (pellagra), and fluoridated water (dental caries) with corroborative detail and combinations of isolated special situations. Such detail is helpful in ruling out some association as not significant etiologically; in this manner, for example, the associations between cholera and altitude (within London) and between pellagra and mill village occupations could be discarded as not significant. For lung cancer, there are as yet no counterparts, for example, to the cholera patient in an isolated rural area who regularly sent for water from the famous Broad Street pump (*19*); to the absence of pellagra among doctors, nurses, and attendants in mental institutions, although the disease was common among patients; to the peculiar age distribution for pellagra in a children's institution where the disease was limited to children between the ages of 6 and 12; to differential attack rates for dental caries by gradations of exposure to fluoridated supplies among natives and in-migrants; and to the sequence of dental events following shifts in the source of a community water supply. Collection of such details generally results from the study of populations. This is one of the reasons why forward studies on lung cancer among defined population cohorts are so important.

Furthermore, the epidemiological models for cholera, pellagra, and dental caries have been put to the test in the successful application of control measures. For pellagra, only the addition of meat and milk to the diet was involved (*26*). Fluoridation effects could be observed under controlled conditions because of the happy accident of public water supplies; if private wells were the only source of water, the problem would have been complicated by self-selection of families fluoridating their own supplies. The test of Snow's conclusions on cholera (*19*), which required implementation through administrative decisions on methods for control of public water supplies, occurred much later, more than 10 years after he had formulated them.

The right combinations of circumstances to permit such straightforward tests of most of the proposed lung cancer etiologies are not present now. Thus, the immediate lines for further work on the nature and meaning of the smoking-lung cancer associations are to develop reasonable facsimiles to tests by control measures and to assemble supporting, corroborative details from population studies, not overlooking any negative evidence which may appear.

Substitutes for Direct Tests

As a substitute for a direct test by control measures of the smoking-lung cancer model one may look for groups in which smoking is either proscribed for religious reasons or does not otherwise form part of the cultural pattern.

Two of the four basic study elements required are at hand: data on the distribution of smoking habits in the United States population (collected as part of the Current Population Survey for February 1955), and data on lung cancer mortality (from publications of vital statistics offices). The major problems would be to secure the cooperation of the groups selected and to develop procedures to obtain the counterparts of these data for their memberships. To avoid artifacts which might be introduced by classification procedures, the primary test must be whether the overall lung cancer mortality in the group studied was markedly less than for an appropriate segment of the population of the United States and commensurate with differences in the smoking patterns. To this, other refinements may be added, such as observing whether mortality differences between the study and control populations disappear when specific comparisons are made by amount of tobacco smoked.

The limited number of countries which can provide reliable diagnostic data on causes of illness and death has discouraged similar studies of groups abroad which have unusual smoking patterns. However, special study situations may be encountered. One illustration is cited, without judgment as to its intrinsic merit. The director of the Hadassah medical organization recently reported the absence of a single case

of lung cancer among Yemenite Jews in Israel during the past 15 years, and he further observed that they did not smoke cigarettes but used a form of Oriental water pipe (*27*). Israel is a country with western standards of medical care and this lead may be worth pursuing. In these matters, the importance of reviewing the primary sources of population, morbidity, and mortality data should be stressed.

Other clues may lead indirectly to population groups with unusual smoking histories. For example, Steiner (*6*), on the basis of necropsy evidence in Los Angeles, has found a possible exception among Mexicans to the usual sex ratio for lung cancer; the proportion of Mexican women with lung cancer at autopsy approaches the proportion for Mexican men. This suggests the need for further studies among Mexicans to confirm the facts and to uncover possible reasons for the aberrant sex ratio for lung cancer. This might conceivably lead to the finding of a group of unusually heavy smokers among women, a useful contrast to the experience of abstainers.

Corroborative Details

Additional details on the nature of the smoking-lung cancer relationship should be assembled from large-scale forward studies. These possibilities were obviously in the minds of those who planned the American Cancer Society and the National Cancer Institute-Veterans Administration studies. Both study groups consist mainly of men between the ages of 50 and 69, the ages of highest lung cancer incidence.

One approach is to expand the evidence on the nature of the association by detailed cross-classification. Epidemiologists have long accepted the principle that the etiological significance of an association is enhanced if it can be shown to persist within a variety of sub-universes. The National Cancer Institute-Veterans Administration cohort can be subdivided with respect to occupation and industry. By lengthening the observation period to several years, further tests can be applied in both studies, including checks on the consistency of regression relationships between lung cancer mortality and amounts of tobacco smoked for several occupational groups and for urban and rural residents.

Additional tests can be pursued by relating age at death to "age started smoking" to see if any consistent pattern emerges.

Studies Among Women

Unfortunately for study purposes, the spread of "age started smoking" is not too great among men, and it may be hard to assemble sizable cohorts for the more unusual combinations of year of birth and "age started smoking." Women would be more promising subjects, since women of all ages began smoking in large numbers during the 1930 decade, and duration of smoking by women is not so closely tied to chronological age. For this reason, more prospective and retrospective studies on smoking and lung cancer among women would be rewarding. In addition to the one series of studies on smoking among women reported by Doll and Hill (*28*), two retrospective studies are known to be under way. The relative rarity of lung cancer among women imposes severe study handicaps and has undoubtedly deterred other efforts.

Potential cohorts for followup would include employed women covered by group life insurance policies. To minimize turnover and loss to observation it would be desirable to restrict the cohort to employees with several years' service.

Studies of lung cancer among women should establish what part, if any, of the sex differential in lung cancer mortality (or incidence) disappears when comparisons are made specific for smoking class. The fragmentary Doll-Hill data suggest that a good part, but not all, of the sex differential may be accounted for in this manner.

Indirect Checks

Retrospective and prospective studies may be viewed as efforts to secure etiologically meaningful data, which official vital statistics sources cannot provide, since they are limited to classification by standard demographic variables. There is another transitional bridge by which vital statistics data on lung cancer deaths can

be utilized. By taking information on smoking patterns in the general population (collected in Current Population Survey for February 1955) and applying to them the data on absolute and relative lung cancer risks by smoking class as reported in the preliminary results of the American Cancer Society study (*29*) and in several retrospective studies (*30*), the "expected" distribution of lung cancer deaths can be computed by sex, urban or rural residence, geographic region, and broad occupational groups, on the assumption that risks by smoking class in the groups studied hold also in the total population. Comparison of the observed and "expected" numbers of deaths would then show how much of the prevailing variation in lung cancer mortality can be accounted for by considering smoking histories. In this manner, some useful consistency checks on the smoking-lung cancer model would be provided.

Such consistency checks need not be confined to smoking histories. The Current Population Survey material illustrates an economically feasible means for remedying some deficiencies in standard population classifications. Although many investigators have expressed the need for procuring information on the population distribution of characteristics under study, they have often been deterred by the cost. Probability sampling methods for gathering such data can provide a powerful tool to the epidemiologist.

Other Possible Factors

Turning from suspected environmental agents with properties which permit direct contact with lung tissue, several possible causes of lung cancer remain. There is the class of environmental agents which do not come in direct contact with lung tissue. Closely related would be possible tissue changes induced by virus and other infectious agents. Constitutional susceptibility might also be considered. If some persons have a predisposition to attacks on lung tissue by some morbid process, the rise in lung cancer might be due to the suppression of "competitive" respiratory causes, such as tuberculosis and pneumonia. Finally, there is the possibility of the association of smoking with other physical, psychological, and emotional factors which may be engendered by the processes influencing persons to take up smoking.

In dealing with lung cancer, where prospects for tests of etiological relationships by trial of control measures are remote, other hypotheses, however unlikely, and the collection of evidence to support or discredit them should be encouraged. The pursuit of other lines of investigation will be useful. If results are positive, another effect of lung cancer will have been discovered; if negative, they will buttress the interpretations applied to effects already known.

Gilliam, in a general discussion of chronic disease epidemiology, alluded briefly to a variety of items investigated by him in a study of lung cancer patients and controls, using the retrospective, case-history method (*31*). These items ranged from color of eyes and use of dentures to histories of illnesses and use of general anesthetics. As he hastens to say, such individual findings cannot be used for any generalizations. However, it may be worth while to inquire systematically into other findings collected but never deemed worthy of report. Several of the other early retrospective studies were "shotgun" inquiries and collected information on a variety of suspected agents and exposures. Collectively, these results might prove useful for testing and discriminating between hypotheses and the planning of further studies.

Several studies exploring characteristics differentiating smokers and nonsmokers may be expected. The question of differences between the two groups arises because smokers select themselves; smoking is not a treatment which can be studied experimentally by randomized application to a population. There is a wide range of possibilities for retrospective studies on the physical, psychological, and emotional attributes of smokers and nonsmokers. The demonstration of an item as being associated with smoking history is essentially a screening device. The further test is whether the item, when applied to a population, produces differences in lung cancer risks equal in magnitude to those yielded by smoking history classifications (if smoking history is uncontrolled), or whether an effect is observed when smoking history is controlled by classification.

Association With Other Illnesses

Some theories on the subsequent increased risk of lung cancer among persons with histories of respiratory illnesses such as influenza, pneumonia, bronchitis, and tuberculosis, based usually on clinical and pathological impressions, have been reviewed by Doll (*32*), who continues on to point out some observations inconsistent with these theories. No associations of lung cancer with the presence or absence of an antecedent illness have yet been established by observations on populations through the use of retrospective or prospective studies. Retrospective studies are handicapped in this field, because patients with lung cancer and other respiratory disorders apparently recall previous respiratory ailments more readily than do other persons. There are some possibilities for forward studies on cohorts known to have recovered from specific illnesses, free from the "recall" bias in the retrospective approach, which may be exploited. For example, records can be assembled of World War I veterans who had influenza and/or pneumonia in 1918. These veterans can be traced forward in time to determine their lung cancer mortality experience. (A study of British veterans (*40*) has been published recently.) From civilian life, one could draw on recovered pneumonia cases reported to health departments in the 1930 decade, when these agencies had active programs based on pneumococcus typing and distribution of serum.

If excess lung cancer mortality among such groups were demonstrated, this would not necessarily be a result of effects of antecedent illnesses. If constitutional predisposition of lung tissue were a factor, the rise in lung cancer mortality might be due to the suppression of tuberculosis and pneumonia as causes of death. If a genetic basis for constitutional predisposition to lung cancer were postulated, other tests could be devised. One approach would be to assemble lists of relatives of diagnosed cases of lung cancer for followup to determine lung cancer mortality. Lists of familial contacts could be assembled from records maintained in tuberculosis control programs. Investigations of this character might be undertaken more readily in some European countries, where population mobility is low and more comprehensive population record systems exist.

Retrospective and Forward Studies

The preceding sections have emphasized the wide range of possibilities for the use of retrospective and forward study techniques. Retrospective, case-history studies use as their point of departure diagnosed cases of a disease and matched controls and compare antecedent events in their previous histories. Prospective, or forward, studies start with the assembly at a fixed point in time of defined cohorts classified with respect to certain attributes, trace them forward in time, and note events occurring subsequently.

Perhaps the major criticism of retrospective studies for lung cancer has been that diagnosed cases have generally been drawn from hospital populations. Positive association between two diseases, not present in the general population, may be produced when hospital admissions alone are studied, because persons with a combination of complaints are more likely to require hospital treatment (*33*, *34*). Smoking is not an illness, and for lung cancer it is difficult to see how the smoking history could have any influence on hospital admission. Lung cancer is a serious disease normally requiring hospitalization, and roughly four-fifths of all diagnosed cases are hospitalized (*35*). The proportion is even higher when microscopically confirmed cases alone are considered. There would have to be extraordinary differences in smoking histories between hospitalized and nonhospitalized patients and controls to upset inferences drawn from hospitalized cases (*36*). So far, the results of forward population studies on excess lung cancer risks among smokers as compared to nonsmokers have agreed in general with those of the retrospective studies. This suggests that biases entering into the selection of hospitalized cases and controls studied retrospectively are probably not the source of the associations noted.

The fundamental assumption underlying retrospective studies and the estimation therefrom of differences in risks between population groups is that the diagnosed cases and controls each be representative of the universe chosen

for investigation. Although there are precautions which can be taken in devising a sampling plan, this representative property cannot be guaranteed merely from internal examination of a single set of data. One must be guided on this point by the comparison of results from several studies and judgment as to the possible biases operating in any setting.

Forward population studies have been questioned on the grounds that the cohorts have not been selected by probability sampling methods and that individual study results cannot be generalized to the total population. The expense involved in tracing cohorts drawn from the general population by probability sampling methods would be great and most investigators have been forced to look for populations followed routinely for other purposes, such as persons covered by employment or insurance benefits.

The criticisms of unrepresentative sampling would appear to disregard the experience available from actuarial sources. There are two common types of insurance: "ordinary" policies, which require applicants to pass a physical examination, and "industrial" policies, which undergo some underwriting selection but require no physical examination. Policyholders would scarcely meet the usual criteria for representative samples. The Metropolitan Life Insurance Co. has published extensive data on the mortality experience of their industrial policyholders and finds rather close agreement with the mortality experience of the general population, after appropriate adjustments for age, sex, and race composition (*37*). Data drawn from actuarial experience and reported in such sources as Length of Life (*38*) and *The Statistical Bulletin*, a monthly publication of the Metropolitan Life Insurance Co., indicate that the relative patterns of mortality with respect to cause, age, sex, race, and geographical region in insured populations have their counterparts in general mortality experience despite some differences in magnitude of rates. The cohorts assembled for smoking and lung cancer investigations do not appear to have been subjected to more rigorous selection than that encountered by industrial policyholders, nor is there reason to believe that the selection effects which did exist discriminated between smokers and nonsmokers. Even when stronger selection effects on mortality experience exist, as in the case of ordinary policyholders, it is well known that the selection effects of physical examinations on mortality experience wear off quickly; very conservatively, in 10 years or less (*39*), usually in about 5 years. If there is any question about the prospective study results on the association of smoking and lung cancer being affected by selection, the conservative course would be to discount the first few years' experience and to require that the early results be confirmed by later experience after selection effects have worn off.

The collation of experience from several studies is also a safeguard against error in generalizing from forward studies on lung cancer. Data from prospective studies may be subclassified by other population characteristics and further checked for internal consistency. With these precautions, the dangers of drawing inferences from forward and retrospective studies inapplicable to the general population seem rather remote.

Summary

The size of the lung cancer problem, as indicated by the number of lives at stake and the economic implications of any potential control measures which might later be advanced, should not blind investigators to the many possibilities for studies similar to those on other chronic diseases which have yielded some of their secrets to the epidemiological approach. Diseases showing pronounced variations in risk among population subgroups are the more amenable to epidemiological study; and lung cancer falls into this category. Studies on human populations should continue to play an important role in delineating possible etiological relationships for lung cancer, the mechanisms for which could then be elaborated by animal experimentation.

Progress must come by the cross-checking of the several results of epidemiological studies, animal experimentation, and other laboratory findings. The issues will probably be settled by an evolutionary process, as was the fluoride-dental caries relationship. Gradually, the meaning of certain associations will become accepted. Dissent will die off and the debate will shift to the many other points in any

epidemiological models still requiring elaboration.

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Ninth Annual Seminar on Seafood Sanitation

The ninth annual Seminar on Seafood Sanitation, sponsored by the Virginia and Maryland State Health Departments, was held in Solomons, Md., September 27–29, 1955. More than 50 persons attended the 5 sessions, which included an inspection of an oyster-packing house and a visit by boat to a soft-clam harvesting area on the Patuxent River.

The first Seminar on Seafood Sanitation was held in 1946 because seafood sanitation specialists found that their work required broad up-to-date technical knowledge. In addition to the common food plant sanitation problems, they were concerned with the construction and operation of municipal and private sewage disposal works; they had to make bacteriological, hydrographic, and sanitary surveys of shellfish-growing areas; and they were obliged to apply the results of these studies to decisions on the suitability of an area for shellfish culture. The seminar has provided a forum where bacteriologists, sanitarians, and sanitary engineers working with seafood sanitation in the Chesapeake Bay area can exchange information on such problems of mutual interest.

Many seafood sanitation problems encountered by county, State, and Federal personnel were discussed at the 3-day meeting. These included sanitary surveys of shellfish-growing areas, general food plant sanitation, sanitation of oyster-shucking plants, sanitation problems in the crabmeat industry, sanitary problems in the new Chesapeake Bay soft-clam industry, preservation of food by radioactive sterilization, and a discussion of the relative merits of State certification of processors of breaded seafood.

Included in the agencies represented in the discussions were State health departments of Maryland, Virginia, South Carolina, Georgia, and the District of Columbia; New York State Department of Conservation; Maryland county health departments which have seafood sanitation programs; the Food and Drug Administration and the Public Health Service; and the Fish and Wildlife Service. The seafood industry was represented by officials of the National Fisheries Institute, the Oyster Institute of North America, and the Oyster Growers and Dealers Association of North America, Inc.

William Ballard, president of the Oyster Growers and Dealers Association of North America, Inc., and operator of one of the world's largest oyster-shucking and packing plants, told of his industry's dependence on sanitation and expressed the opinion that the future of the seafood industry rested with the accomplishments of the fisheries research scientists and with the seafood sanitation specialists.

The participants recommended that the health departments of Maryland and Virginia sponsor another seafood sanitation seminar in 1956.

Federal and State health authorities and representatives of State medical societies met during March and April 1955 to consider the health problems involved in protecting the civilian population from the effects of modern weapons of war. The conferences, which were held in each of the nine regions of the Department of Health, Education, and Welfare, were conducted by the Public Health Service in cooperation with the Association of State and Territorial Health Officers, the Federal Civil Defense Administration, and the American Medical Association. Emphasizing that it expects to discharge its civil defense responsibilities to the very best of its ability, the Public Health Service reported its existing plans and activities and presented current facts related to defense against biological, chemical, and radiological warfare. An important objective of the conferences was to secure advice from the States as to how the Service can best help them in providing the health services needed in civil defense. One of the conference papers is given here in full, and five others are given in brief. A seventh paper, a discussion of biological warfare defense by Keith H. Lewis of the Robert A. Taft Sanitary Engineering Center, was omitted from this summary. A glossary on radiation terms appears on p. 192.

Biological-Medical Considerations in Atomic Defense

By EDWIN G. WILLIAMS, M.D., and SAMUEL C. INGRAHAM II, M.D., M.P.H.

THIS discussion of defense against atomic attack centers around atomic radiation, as distinct from the blast and heat effects of a nuclear reaction. Right at the start, we need to pause for a moment to gather some perspective on the problem of radiation from a nuclear weapon. As stated in a recent Federal Civil Defense Administration publication (*1*):

"A surprise daylight attack with a nominal bomb [20 kilotons] exploded at 2,000 feet over an 'average' metropolitan area would produce a total of about 120,000 casualties—killed and injured.

"Of this total, 40,000 (33⅓ percent) would either be killed outright or would die the first day. . . . Thus, probably 80,000 casualties (66⅔ percent) would survive the first 24 hours. Of these 80,000 it is estimated that:

48,000 (60 percent) would be suffering from burns;
40,000 (50 percent) would be suffering from mechanical injuries;
16,000 (20 percent) would be suffering chiefly from radiation injuries."

NOTE: The total exceeds 100 percent because many of the casualties would be suffering from two or more types of injuries.

Thus, we see that radiation injuries are expected to constitute only a small percentage of

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the total injuries caused by an atomic bomb attack. But treatment of burns and traumatic injuries, from which 80 plus percent of the casualties would be suffering, are a well-accepted part of orthodox medical practice; so, albeit somewhat arbitrarily, we are disregarding the vast problems of these injuries. Radiation injuries, on the other hand, are novel to many physicians, and for most nonmedical people they carry an aura of absolute mystery. For this reason alone, we shall limit this discussion almost exclusively to the radiation aspects of nuclear weapons.

The increasing size of atomic explosions and the development of hydrogen-fusion bombs with the power of millions of tons of TNT have recently increased probability of radiation injury from nuclear weapons. The following information, based on an official release of Chairman Louis L. Strauss, Atomic Energy Commission, was published recently (*2*):

"Fallout from [a] hypothetical H-bomb dropped on Washington, D. C., . . . could cause deaths as far as New York City, 220 miles away. In [a] 10-mile-wide circle everything would be wrecked by blast. Heavy chunks of radioactive debris would rain down. But lighter debris and dust would be blown 80,000 feet high. Assuming . . . that winds are northward [which the prevailing winds are], the dust cloud would drop its radioactive cargo in [a] cigar-shaped zone about 220 miles long and over 20 miles wide. Radiation, decreasing with distance from the blast, would be nearly 100 percent lethal for unprotected persons out to 140 miles from ground zero [these days it really is '*area zero*'], diminishing to 50 percent lethal between 140 and 160 miles away, and dropping from 10 percent lethal to safe between 160 and 220 miles away."

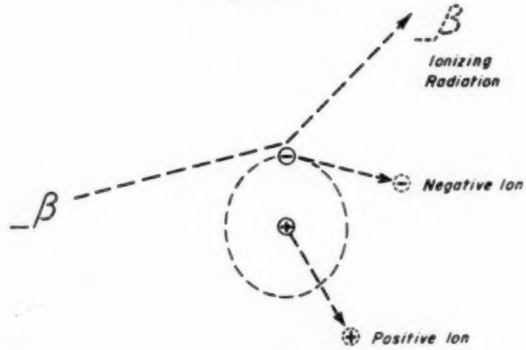
Contrast this radiation effect to that of an atomic bomb, where the expected number of persons disabled by radiation is relatively small. The fallout from hydrogen bombs could affect many millions of people. In certain population areas, several million could be exposed to a lethal dose.

Now, with another reminder that radiation comprises only one phase of the medical problem in atomic warfare, we shall consider pertinent biomedical effects of radiation.

How Radiation Affects Tissue

Atomic radiations, whether they arise from nuclear weapons, from radioisotopes or radium, or from radiation-producing machines, share one distinctive property: During the process of absorption in the body, they all interact with tissue by splitting atoms and molecules into pairs of electrically charged fragments called ions (fig. 1).

Figure 1. Ionization of a hydrogen atom by a beta particle.



The remarkable effectiveness of atomic radiations in causing biological injury stems from their property of acting directly on the individual atoms and molecules composing tissue. By their ionizing effect, radiations may eject electrons from atoms, break up chemical compounds, displace atoms in organized molecules, generate toxic substances and, in general, cause important changes in the submicroscopic structure of body cells.

The potency of radiations may perhaps be appreciated more concretely if one compares, for example, the power of alpha particles (to ionize and injure molecules) with the power of shotgun pellets (to injure people). Relative to their respective targets, alpha particles are 28 times heavier than No. 5 shot (fig. 2). And the speed of 1-Mev. alpha particles exceeds the muzzle velocity of No. 5 shot from a 12-gauge shotgun by well over a quarter of a million times. A shotgun fired at a man can injure or kill him. Alpha particles striking tissue can ionize its molecules and injure or kill its cells. A single shotgun pellet, if it strikes a vital spot, can be fatal. A single alpha particle (or for that matter, any other single radiation), if it

ionizes a critical molecule, can kill a cell or possibly start a cancer.

The specific injury produced by radiation in any given circumstance probably depends on many variable factors, such as the density of ionization, the kind of tissue irradiated, and the kind or location of the molecules affected. Observed injuries include the mutation of genes, inactivation of enzymes, inhibition of cell division, and fatal disturbance of tissue functions.

So far as we know, there are four possible results of exposing a living cell to radiation (fig. 3). The cell may be killed. It may be crippled, transiently or permanently. Or it may merely have nonessential molecules ionized and, therefore, actually not be harmed at all by the radiation. Symptoms of radiation injury (skin erythema, radiation sickness, decreased fertility) appear in an individual only after a sufficient number of cells have been injured or killed. Unless the exposure has been sufficient to cause skin erythema, there may be no immediate external warning that a sublethal or even a minimum lethal dose of radiation has been received. Some changes appear early. Others may be seen only after prolonged periods of latency. Evidence of injury from minimal doses of radiation may not show up for months or even years.

The recognizable changes produced in cells by radiation are of many sorts. They include changes in permeability of the cell membrane, changes in the staining characteristics of cells, changes in viscosity of the protoplasm, changes in chromosomes, swelling of cellular components, production of abnormal cell divisions, distortion of cell structure, and many more obscure but measurable changes.

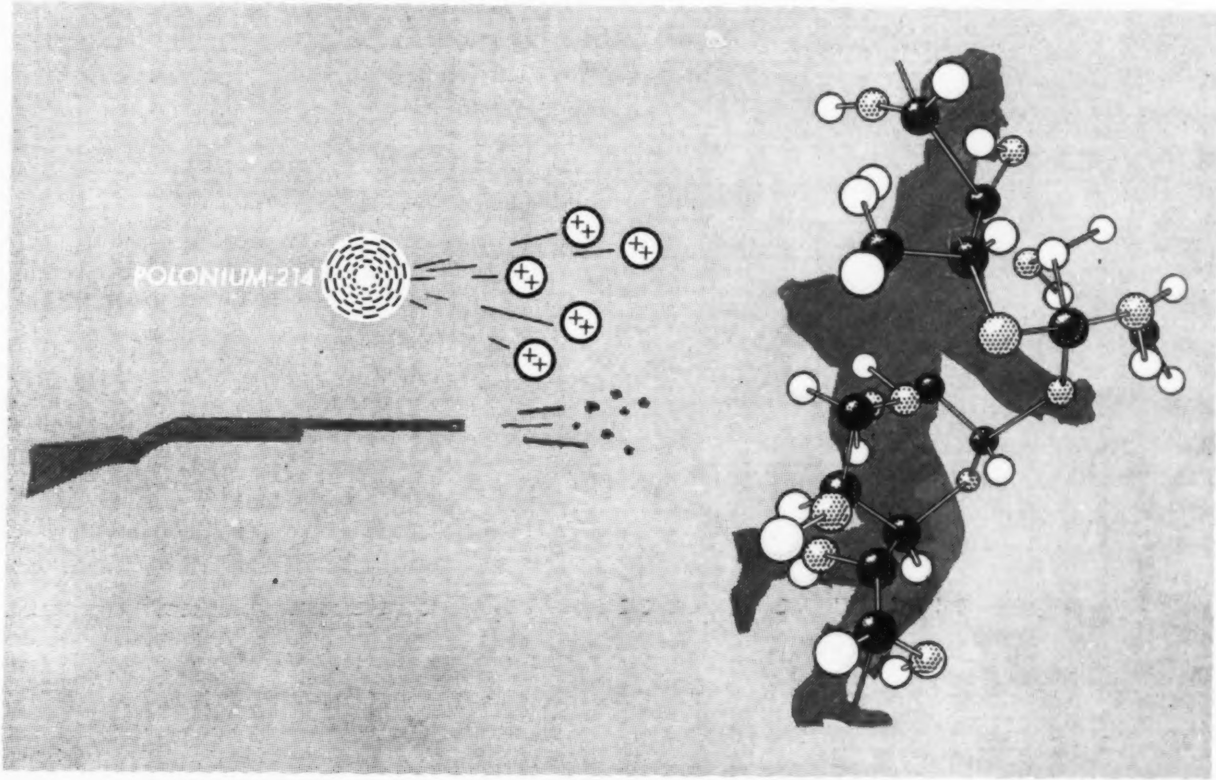


Figure 2. Comparison of the power of alpha particles to injure a molecule with the power of shotgun pellets to injure a man.

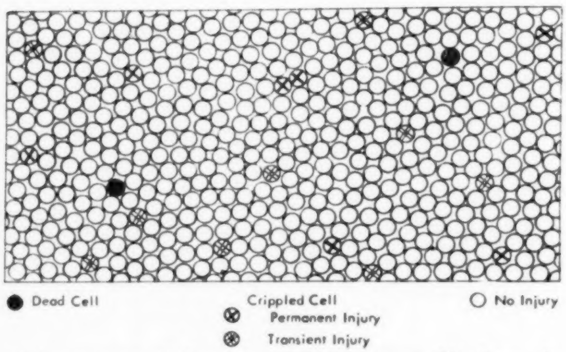
Variations in Radiosensitivity

Each of the human body's many different tissues responds differently to radiation exposure. The responses, in general, are a summa-

tion of the responses of the various cells and cell types composing the specific tissue.

Rapidly growing or metabolizing tissues are usually more sensitive to radiation than are quiescent tissues. Lymphocytic tissues (lymph nodes, tonsils) are more easily affected than are muscle or nerve tissues. Tissue cells in an organ are more easily injured by radiation than tissue cells grown in a culture.

Figure 3. Diagram of irradiated tissue.



Tissues so differ in reaction to radiation absorption that it is possible to classify them, in a loose fashion, according to the doses of radiation they will successfully withstand. Any such classification is empirical and, since it disregards important variables other than dosage, is far from exact. Various authors place some of the tissues in a slightly different order of radiosensitivity. However, the principle of specific tissue sensitivity is generally accepted. The following list is based on the available data and represents the approximate response of tissues exposed to divided doses of roentgen rays generated at 200 kilovolts (*3*) :

Highly radiosensitive (cells seriously injured or killed by doses of 600 roentgens or less) : lymphocytes; bone marrow cells; sexual cells (testicle and ovary).

Moderately radiosensitive (cells seriously injured or killed by doses of 600 to 3,000 roentgens) : salivary glands; epithelium of skin; endothelium lining blood vessels; bone (growing) ; epithelium of stomach and intestine; connective tissue; elastic tissue.

Radioresistant (cells show little damage unless dose exceeds 3,000 roentgens) : kidney; liver; thyroid, pancreas, pituitary, adrenal, and parathyroid glands; bone (mature) ; cartilage; muscle; brain and other nervous tissue.

Quite recently, we have been told that the organ systems most fundamentally affected are the central nervous system, the blood forming organs, and the gastrointestinal tract. Nerve tissues, for example, do not recover from injury as do many other tissues.

The recovery of tissues showing any specific radiation effect is dependent upon the ability of the individual cells composing it to recover and reproduce. This in turn depends upon the dose of radiation absorbed and the types of cells present. The blood forming organs, the skin, the membranes lining body cavities, and the secreting glands may regenerate completely and resume their normal functions. Muscle, brain, and portions of the kidney and eye cannot regenerate; repair of them results only in scar formation. Even those tissues that can regenerate may fail to respond after repeated ionization and so cause conditions such as nonhealing ulcers or aplastic anemia. Also, repeated regeneration may produce cancerous conditions: epitheliomata, fibrosarcomata, or leukemia. These changes have all been observed in animals following radiation exposures at levels corresponding to doses only slightly above the accepted safe limits for man. There are no constant clinical symptoms which can be relied upon to warn of latent radiation injury before the late changes become manifest.

Not only is there marked variation in radiation sensitivity of different kinds of cells and tissues within an individual; there is also some variation in the radiosensitivity of individuals of the same species and even more variation among different species.

If killing power is selected to measure the effect of radiation exposure and if mice are selected as the test animals, it may be demonstrated that as the dose of X-rays given over the entire body increases from 200 to 1,000 roentgens the acute mortality rate from irradiation in successive groups of exposed mice will increase from 10 to 100 percent. In addition, the onset of lethal effect will show a latent period which shortens from 8 to 2 days or less as the radiation dose is increased.

If the dose of radiation that within 30 days will kill 50 percent of the individuals exposed (median lethal dose or LD_{50}) is selected as a measure of the biological effect of radiation, the variation in radiosensitivity from animal

species to animal species becomes apparent. The approximate LD_{50} X-ray doses for several of the more common experimental animals (based on actual experiments) and the estimated median lethal dose for man (based on animal experiments, reactions of X-ray therapy patients, and data collected in Japan) are as follows:

Animal	*Dose (roentgens)*
Guinea pig	175–250
Dog	325
Goat	350
Man	400–450
Mouse	530
Rabbit	800
Rat	825–900
Weevils	1,000–2,000
Molds	2,000
Bacteria (nonspore forming)	1,500–2,000
Bacteria (spore forming)	20,000–50,000
Viruses	50,000–1,000,000

The potency of radiation to injure tissue is possibly better appreciated when one realizes that 1 roentgen produces about 1,000 ionizations among the atoms in each body cell exposed. Since the adult human body is composed of about 140 trillion cells, this means that exposure of the whole body to the maximum permissible dose for radiation workers (0.3 roentgen per week) will result in about 7 quadrillion ionizations per working day in the body. The human LD_{50} dose (450 roentgens) will ionize about 1 atom in every 100 million in the body, or about 450,000 atoms per cell, on the average.

Effect on Life Expectancy and Fertility

Experimental observations of many different species indicate that radiations induce an aging and debilitating effect. Each roentgen of exposure probably shortens life expectancy of an animal by about one ten-thousandth. This implies that an exposure rate of 0.4 milliroentgen equivalent physical per day (about what man receives from cosmic and other naturally occurring radiation) may shorten the expected life span of a human being by about 4 weeks, if the effect of radiation in man is like that in animals; or 50 roentgens of exposure may shorten the expected human life span by as much as 18 weeks. Also, radiation exposure induces an increased susceptibility to infection.

There is a wide range of specific radiation effects from a wide range of doses. In general, the larger the dose, the more prompt and dramatic are its biological effects; the smaller the dose, the more delayed and more insidious are its biological effects.

In every discussion of the effects of ionizing radiations one of the first questions put to the physician is, "Will it make me sterile?" In response, the physician usually finds it necessary to distinguish between potency and fertility. No direct effects on potency have been reported. Fertility has been affected.

Permanent sterilization of the human female requires 400 to 600 roentgens delivered to the ovary. Sterilization of the human male can be produced by 800 to 1,000 roentgens delivered to the testes. Either of these doses given as whole-body radiation would probably be lethal to the individual, and so danger of causing permanent sterilization by single whole-body exposures becomes a theoretical rather than a practical question. Reduced fertility and temporary sterility have been induced in human beings by single exposures of 200 to 300 roentgens to the gonads and in animals by repeated exposures of as little as 1 roentgen per day for a number of weeks.

A survey a few years ago found that the average number of children born to a group of radiologists was 1.7, whereas the average number of children born to a comparable group of physicians not engaged in roentgenology was 3 (*4*). Inasmuch as the major difference between the two groups of physicians, so far as could be determined, was the practice of roentgenology, these data may indicate a reduction in human fertility from repeated exposure to relatively small doses of X-rays.

Effect on Genes

Genetic, or hereditary, changes may arise from doses of radiation much smaller than those needed to affect fertility. Many genetic experts believe that *any* amount of ionizing radiations may produce hereditary changes cumulative throughout the lifetime of the germ plasm line that can and will appear in future generations. There is, however, no current evidence that radiation workers (X-ray technicians, radiolo-

gists, atomic workers) who have not abused the maximum permissible dose limits have produced offspring differing from those of the general populace.

Specifically, from the human genetic studies being made of the completed pregnancies among the surviving victims of the atom bombings at Hiroshima and Nagasaki, at least one positive finding has been reported. The expected normal male-female ratio has been upset among offspring of women exposed within 2,000 meters of ground zero (the point immediately beneath the exploding bomb) by a statistically significant decrease in male births (*5*).

Ionizing radiation can alter the genes in the body (somatic) cells and in the reproductive (sexual) cells and so cause them to grow or reproduce abnormally. If a gene change occurs in a sexual cell, a mutation will occur in later generations provided that the cell is used in reproduction. If a gene change occurs in a cell of growing or regenerating somatic tissue like skin, liver, bone, or bone marrow, it may cause cancerous or other harmful changes in the exposed individual.

Both somatic and sexual cell mutations produced by radiation have been observed in human beings. Statistically significant increases in numbers of mutations have occurred in offspring of parents with a history of exposure to either acute or chronic radiation. An increased incidence of cancers has been recorded in people exposed to amounts of radiation similar to those that produce genetic mutations or cancers in animals. Peller and Pick (*6*) in 1952 reported that among physicians in the United States, there were 8 to 9 times as many fatal cases of leukemia among radiologist physicians as among nonradiologist physicians.

The probability that a cell may be ionized increases in proportion to the number of cells exposed to radiation. As there are many more somatic cells than sexual cells in the human body, somatic cells are the more likely to be changed genetically from a given whole-body exposure. Thus, from the point of view of radiation-produced gene changes and their effects on human beings, one probably should avoid needless radiation exposure at least as much for his own health protection as for the genetic protection of his progeny.

A Calculated Risk

In the civil defense program, we must think of radiation exposure in terms of calculated risk. Exposures ought to be held as low as possible, but doses permitted must allow for such exposures as are unavoidable in accomplishment of essential missions.

No predetermined dosage schedule can be set, in advance of an emergency situation, that will evaluate the relative importance of a given civil defense mission. This evaluation is a command decision to be made by the responsible civil defense official on the spot, at the time. However, one guide in such decisions will be the following data on radiation effects, which were compiled for the FCDA:

Dose (roentgens)	*Observed effects*
0–25	No obvious injury. An average person receives 10–20 roentgens over a lifetime from naturally radioactive sources.
25–50	Least clinically detectable exposure—possible blood changes but no serious injury. 50 roentgens in 1 day is safe if not repeated too soon.
50–100	Blood cell changes, some injury, no serious disability. 100 roentgens causes sickness to approximately 10 percent of the persons receiving this dose.
100–200	Injury, possible disability, probably no deaths. 150 roentgens causes sickness to approximately 25 percent.
200–400	Injury and disability certain, death possible. 200 roentgens causes sickness to approximately 50 percent, death to approximately 2 percent. 300 roentgens causes death to approximately 20 percent.
400–450	Fatal to 50 percent of persons exposed; death occurs within 2 to 12 weeks.
600 or more	Lethal dose causing death to nearly all persons exposed within 2 weeks.

As with other biomedical values, there is nothing magical about the roentgen values given here. The several effects listed merge gradually one into the other as the dosage increases; so, if another table shows slightly varying values, one should not consider this or that table correct and the other one wrong. Rather, the differences will probably be an expression of the normal range of values seen in any biomedical situation.

Among atomic bomb casualties there will be many with multiple injuries. Dual or triple modes of injury may be the rule rather than the exception. Victims may have burns, traumatic injuries, and radiation injuries in any combination. Prognosis in each case will depend on the types and extent of the injuries. Those with radiation injuries in addition to more orthodox injuries will tend to have a graver prognosis than those not having radiation injuries. The reason for this is that one of the important effects of whole-body exposure to atomic radiation is to impair the effectiveness of body mechanisms responsible for resistance to infection and disease and for healing and repair of injured tissues.

Radiation exposure incurred from the atomic flash is, of course, practically instantaneous. That from radioactive fallout, because of the rapid decay of this material, should be thought of as being suffered within a quite short time span: More than 80 percent of the radiation dose from atomic debris will be delivered within 10 hours of the explosion time. The radiologists tell us that radiation exposures delivered over a time span of minutes or hours may be thought of as having effects identical to an instantaneous exposure of the same roentgen value. On the other hand, exposures incurred over a period of days or months have less total biomedical effect on the body as a whole than would the same cumulative roentgen dose if it were delivered over a period of only hours or minutes.

Radiation Sickness

Radiation sickness is the term used to describe the illness produced by overexposure to atomic radiations. The accumulated evidence indicates that radiation sickness represents a symptom complex which may be divided into the following five groups:

1. *General symptoms:* Headache, vertigo, debility, abnormal sensations of taste or smell.

2. *Gastrointestinal symptoms:* Anorexia, nausea, vomiting, diarrhea.

3. *Cardiovascular symptoms:* Tachycardia, arrythmia, fall of blood pressure, shortness of breath.

4. *Hematological symptoms:* Leukopenia, thrombocytopenia, increased sedimentation rate, decreased resistance to infection.

5. *Psychic symptoms:* Increased irritability, insomnia, fear.

Not all the symptoms of radiation sickness occur in each patient. Also, the same patient may react differently at different times to similar radiation doses. In general, the greater the radiation exposure, the quicker and more dramatic is the appearance of radiation sickness. For those interested in more details of human and animal responses to radiation exposure, it is suggested that they refer to the voluminous medical and other scientific literature on this subject.

Therapeutic Measures

There are no known specific agents for the treatment of radiation injury. There are no practical prophylactic drugs to temper or avert radiation injury consequent to adequate exposure to radiation. Medical research is continuing in an effort to discover and develop better means of diagnosis, prophylaxis, and treatment for the victims of all types of radiological hazards, including atomic attack.

The recommended therapeutic measures for radiation sickness and its sequelae are almost exclusively symptomatic or supportive in nature. They include:

1. Bed rest plus sedatives to reduce stress demands on the body economy.

2. Therapy to improve nutrition and maintain fluid and mineral balance.

3. Measures to reduce or prevent infection: Antibiotics; aseptic techniques in nursing and medical care with emphasis on mouth and skin hygiene; leucocytic cream.

4. Antishock drugs.

5. Antihistamines (on the theory that shock is precipitated or made worse by histamine produced by the radiation-injured tissues).

6. Antigastric secretants and antinauseants.

7. Antihemorrhagic drugs.

8. Miscellaneous drugs, such as glucose, glucose-saline injections, cholesterol, liver preparations, numerous vitamins, alcohol, insulin, corpus luteum hormone, Congo red desoxycorticosterone acetate (DCA), and ACTH.

9. Blood transfusions.

The opinions about the therapeutic values of these proposed measures are as varied as the number of substances listed.

Attempts at prophylaxis or prevention of radiation injury by pretreatment has been tried in animals with varying degrees of apparent success. Desoxycorticosterone acetate (DCA) has had some favorable effect in delaying radiation death as have cysteine, glutathione, and rutin. Subcutaneous or intermuscular injection of heterologous bone marrow appeared to have success as a radiation protectant for mice. The latest, most hopeful drug being tried is beta-mercaptoethylamine.

Probably the best summarization of present-day treatment measures for radiation sickness is contained in the final paragraph of the Report on the Medical Studies of the Effect of the Atomic Bomb by Dr. Masao Tsuzuki, professor at Tokyo Imperial University and chairman of the medical section of the Japanese National Research Council. Even though this document is now more than 6 years old, Dr. Tsuzuki's statement is still timely:

"The most important measures for the treatment of the radiation injuries is careful protection. All patients are affected more or less by the radioactivity; these must recover by their own vital power. In the cases in which the vital organs are damaged beyond their ability to recover, medical care at the present time cannot help. We may have some hope of recovery as long as any reserve power is remaining because the radiation exposure has occurred only once. We must, therefore, avoid such treatment as whipping a tired horse hastily. In other words, we should not be overconfident in the ability of our medical care. Our aim shall always be a promotion of the natural healing powers."

Public Reaction

Quite as serious as the physical problem of radiation control is the problem of the public's psychological reaction to the use of radiation. Misunderstanding of radiation coupled with fear of the unknown are usually enough to make a public wary of anything connected with atomic radiations. An injudicious warning about radiation may needlessly increase the difficulty of civil defense activities in the presence of atomic attack. On the other hand, it may be an even worse mistake to pay no heed to the hazards. Public health and civil defense workers can meet this issue by viewing radiation in proper perspective so as to establish and maintain measures for protection without doing psychological damage by their attitudes and statements. Once exposure has occurred, little can be done about the injury. It will not improve the situation to alarm or depress those who have been injured.

Radiation constitutes only a portion of the problems created by nuclear weapons. The major companion problems will be care for burns and traumatic injuries plus an enormous task of sanitation and hygiene for the homeless and dispossessed.

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Radiological Defense

PHR brief

Radiological defense is a part of the integrated defense system of this country. It requires the knowledges and skills of specially trained technicians. However, many simple precautions of a nontechnical nature can be utilized to protect the public.

The detonation of a nuclear weapon is accompanied by the physical phenomena of light, heat, and blast and also by instantaneous nuclear radiations. The magnitude of each of these phenomena is proportional to the energy released in the detonation. Since we cannot see, hear, feel, taste, or smell ionizing radiation and radioactivity, they must be detected and their magnitude measured by sensitive instruments.

A great deal of what has been written about the effects of nuclear weapons is summarized in the accompanying chart. Incident thermal radiation on exposed skin will cause a first degree burn if the intensity is 2–3 calories per square centimeter, a second degree burn if the intensity is 3–7 calories per square centimeter, and a third degree burn if the intensity is 8–10 calories per square centimeter. An overpressure of more than 35 p.s.i. is required to do bodily harm to a person by blast alone. An overpressure of 19 p.s.i. will damage buildings irreparably; 19–6.6 p.s.i. will cause heavy damage; and 6.6–3 p.s.i. will cause moderate damage. Nuclear radiations released at the time of the explosion do not present a serious hazard beyond the effective range of heat and light. A longer-term hazard is created by the byproducts of the reaction: radioisotopes which fall out of the clouds.

Fallout and Monitoring

As the cloud raised by a nuclear blast carries radioactive dust and debris aloft, this matter is swept out by shearing winds. The constituents of the cloud from a large thermonuclear weapon are as radioactive as millions of tons of radium. Fallout contains many species, or kinds, of radioactive materials, each of which decays at its own specific rate. Decay means that the atoms change to other elements; in the process radiations are released. The apparent radiation released by the fallout during the decay process is actually the sum of the radiations released by each individual radioisotope present. Both the decay rate and the intensity of radiation released in the decay process are indicated by the half-life of the material. The half-life is the time required for one-half of the atoms of a given material to decay. The shorter the half-life, the faster the decay and the greater the intensity of radiation produced by the decay process.

To monitor, or measure, the extent and magnitude of radioactive fallout, trained personnel use radiation detection instruments. Monitoring by plane is recommended in the early stages; ground monitoring should follow. The area contaminated by a fallout may be larger than 10,000 square miles.

By Simon Kinsman, Ph.D., associate chief of the Training Section, Robert A. Taft Sanitary Engineering Center, Public Health Service, Cincinnati, Ohio.

Estimating the Hazard

The half-lives of the radioactive materials in the atomic cloud range from a few seconds and minutes to thousands of years. The fallout will contain many radioactive species, some of which can be an internal hazard if admitted to the body, and all of which can constitute an external hazard when outside but in the vicinity of the body.

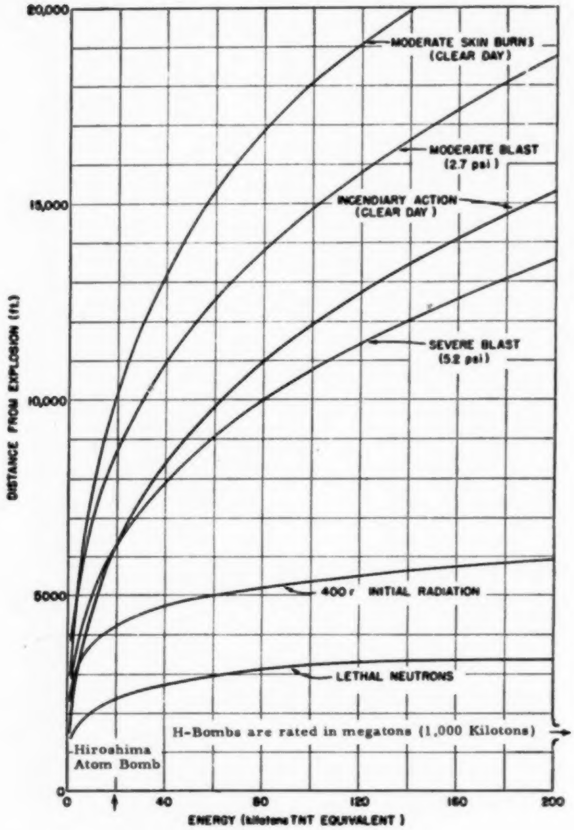
Estimates of the amount of radiation which a person might receive while in a fallout area are based on an empirical relationship between the initial intensity of the radiation from all the fallout materials, the time elapsed between the detonation and the start of exposure, and the length of time in the area.

As soon as the aerial monitoring crew can furnish a reading of average radiation intensity for an area or as soon as the ground monitor can give an average radiation intensity for a street, block, or even a room which has been contaminated with fallout, it is possible to calculate the intensity of radiation in that locality at any future time, providing, of course, that no decon-

tamination procedures are used and no additional contamination occurs. Tables, curves, and slide rules are available from which solutions to the problem can be read directly.

If the intensity of radiation remains relatively stable, as it does in the vicinity of long half-life radioactive materials, such as radium, uranium, or plutonium, the total dose of radiation can be determined simply by measuring the radiation intensity with an appropriate instrument and multiplying the result by the exposure time. When the intensity is on a sharply declining scale, as it is in a fallout area, probable exposure can be estimated by means of calculus. Tables, curves, and slide rules are also available for obtaining solutions to this problem directly.

Distances from explosion at which various effects are produced as function of bomb energy.



Decontamination

Radiological decontamination is still an unrefined science. Wise counsel is to avoid contamination if possible.

There is no practical way to destroy radioactivity. Since radioactive decay is entirely unaffected by physical or chemical reactions, decontaminating solutions such as those used in neutralizing mustard gas contamination are of little value against radioactive materials. The objective of radiological decontamination is to free an area from persistent radioactive agents. This necessitates removal and segregation of microscopic quantities of induced radioactive isotopes, fission products, and unfissioned parts of the bomb fuel.

Currently accepted principles of decontamination suggest the following procedures:

1. Immediate reduction to a minimum of that contamination of personnel and vital installations which cannot be or has not been avoided, by means of (*a*) complete bathing, monitoring, reclothing, administering of medical treatment when required, and evacuation of affected personnel; (*b*) washing and scrubbing down exposed surfaces to free them of loose contaminating particles; (*c*) temporarily covering short-range emitters (alpha or beta) with a coating, such as paint, to provide a partial shield against the emissions and prevent the spread of contaminants.

2. Subsequent thorough decontamination of areas important enough and of low enough radiation intensity to warrant such action, which may include (*a*) repeated scrubdowns; (*b*) removal and collection of closely adhering particles by using such chemicals as citric or hydrochloric acid, which make the particles more soluble; (*c*) removal and segregation of the surface to which the particles cling by using paint-removing solutions, scraping, or possibly wet sandblasting (if the surface material can be gathered for segregation).

3. Prevention of the spread of contamination, which may be accomplished by (*a*) preventing access to particularly "hot" areas; (*b*) using great care in disposing of grossly contaminated objects and the water and materials used in removing contaminating particles; (*c*) carrying out a carefully prescribed ventilation doctrine in air-conditioned shelters; (*d*) improvising a change station or decontamination center for the thorough decontamination of personnel and

their clothing and equipment (clothing may have to be buried).

The value of the operations mentioned in "1" and "2" should always be weighed against the possibility of temporary or permanent abandonment of the area or installation or the possibility of prescribing maximum periods of working time therein.

Salvaging Food and Water

Food in the damaged area may contain some induced radioactivity, but it is unlikely to be present in hazardous amounts. The largest source of contamination is fallout. Radioactive dusts may be deposited on foods or in water.

With respect to food or water that may be seriously contaminated, remember that radiation is less of a hazard when the source is outside the body than when it is within the body. Decontamination or shielding of the skin is far easier than decontamination of the lungs, liver, or bones.

To prevent accidental ingestion of radioactive materials, isolate all unpackaged foods that were located where the dust from a ground burst or mist from an underwater burst might have settled on them. Before opening canned or bottled foods, wash the outside of the container thoroughly. Also scrub all cooking utensils and tableware exposed to radioactive dust or mist. Foods and utensils in tightly closed drawers or cupboards will not be contaminated by fallout.

Water inside household pipes at the time of the explosion will probably not be seriously contaminated. If pressure is available, a little water can be drawn off immediately after the burst and placed in clean containers with covers. This water will be safe for consumption. Although the chances that the city water supply will be radioactive are pretty slim, be cautious about using tapwater for drinking thereafter. If possible, wait until official word is received that the water is safe.

General Information

All radiation is damaging and should be avoided whenever possible. In time of disaster, standards of permissible radiation tolerances will have to be changed from peacetime to emergency levels. The amount of exposure to radiation will have to be weighed against the necessities; that is, it will be a calculated risk. If protective practices are observed, however, the chances of survival will be increased.

Alpha, beta, and gamma radiation will not cause foods, water, or the person to become radioactive. Neutron flux may induce some radioactivity, but everything within the neutron range will probably be damaged beyond recovery by blast and heat. Radioactivity in foods, water, or the body is the consequence of deposits of radioactive elements produced by nuclear reaction.

Because radioactivity cannot be liquidated, the handling of people or objects contaminated with radioactive materials is somewhat different from the handling of people or objects contaminated with any other type of dust. If a person handles people or objects contaminated with radioactive materials, he himself will not become radioactive, but some of the radioactive dust may attach itself to his clothing or body. Decontamination usually takes the form of scrubbing with soap and water. However, since you can't destroy radioactive materials, the wash water must be so disposed of as to guard against entry of the materials into the water supply.

In regard to shelter and shielding from radiation resulting from radioactivity in the fallout area, as long as we can prevent internal contamination, we need consider only gamma radiation. Assuming that the shelter is beyond the range of the instantaneous gamma radiation produced by a 15-megaton weapon, the following tabulations, prepared by Dr. R. E. Lapp, show the extent of the fallout areas that may be expected from this weapon, the average intensities of radiation in these areas, and the corresponding attenuation of radiation that may be expected from shielding material:

Time after burst (hours)	*Fallout area (square miles)*	*Average intensity of gamma radiation (roentgens/hour)*
1	250	2,500
3	1,200	200
6	4,000	30

Reduction factor	*Concrete (inches)*	*Packed soil (inches)*
10	6	11
50	11	18
100	13	21
1,000	19	30

It has been reported that a dose of whole-body radiation of 600–700 roentgens received in a short period of time would be fatal to all recipients. An unprotected person in the 250-square-mile area 1 hour after the atomic explosion would receive this radiation dose (625 roentgens) in 15 minutes. However, if a person were behind 30 inches of packed soil or 19 inches of concrete, the radiation intensity would be reduced by a factor of 1,000 and he would receive radiation only at the rate of 2,500/1,000, or 2.5, roentgens per hour. This dose rate would diminish with time, and the chances are that the person behind this shield would not suffer serious effects from the exposure.

Chemical Weapons

The threat of the employment of poison gas as a weapon of war presents a problem which cannot safely be ignored by either military or civil defense planners. This fact is well recognized by the military staffs of all major powers, and it has always been an important consideration in the civil defense programs of the European countries.

Prior to World War II, it could perhaps be accepted that the logistical requirements of long-range air attack with the then known toxic agents provided a margin of safety for the United States. Except for the doubtful event of an enemy securing a beachhead on our shores or in some nearby territory, it seemed unlikely that the citizens of this country would be exposed to the cyanides, the mustards, or the phosgenes.

Developments during and since the war have completely changed the situation. The emergence of the nerve gases, sometimes called G agents, as toxic agents produces a threat to people located anywhere that a plane or guided missile can reach. These agents are in the possession of both democratic and Communist forces. And the extreme lethality of these new organo-phosphorus compounds meets all the logistic requirements for long-range attack. Nerve gas is a killing and disabling instrument—make no mistake about that—and it produces these effects with relatively minute quantities compared to the older compounds.

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Effects of Nerve Gases

Nerve gases, either in the liquid state as loaded in munitions or in the vapor state following shell or bomb detonation, are colorless and virtually odorless. In the vapor form they may attack through the eyes, or they can be inhaled or ingested. In the liquid form they can be ingested, or they may attack systemically through the unbroken skin. The symptomatic effects usually follow this sequence: contraction of the eye pupil, tightness of the chest, labored breathing, nausea and diarrhea, muscular twitching and convulsions, and rapid death unless countermeasures are taken promptly. Death occurs in a matter of minutes for unprotected individuals exposed to lethal concentrations of nerve gas.

These substances are the most powerful enzyme inhibitors known. A nerve impulse reaching a muscle plate produces acetylcholine from the choline and acetate in the tissue. This acetylcholine, which stimulates the parasympathetic nerve system, is normally controlled by cholinesterase. Nerve gases and cholinesterase react irreversibly in the tissue fluid, permitting the acetylcholine level to build up and causing continual stimulation of the parasympathetic nerve system.

Rapid use of blocking agents, such as atropine salts, is required to nullify the effect of the acetylcholine. The atropine salts, usually in the form of the sulfate or the tartrate, are made in ampins or syrettes containing 2 mg. each. Atropine self-injection devices for treatment of nerve gas casualties are being stockpiled by the Federal Civil Defense Administration.

Following exposure to a nerve gas attack, it is recommended that, if pupillary contraction or difficulty in breathing is encountered, an injection of atropine be administered at once. If the symptoms progress rapidly to the convulsive stage, two more injections of 2 mg. each should

be given immediately. An unconscious person should receive three injections, totaling 6 mg. of atropine, followed by artificial respiration.

Because of difficulties associated with self-treatment, it may be advisable to recommend to the public that atropine injections be given by someone else whenever possible. However, in the event of a successful gas attack, affected persons within the zone of the gas cloud, including those in the impact area and downwind, must be treated promptly to prevent death.

Detection and Identification

Special kits have been developed by the Chemical Corps of the Army for detecting and identifying chemical agents encountered in the field and for collecting samples for laboratory identification.

If used overtly, chemical agents probably would be disseminated in the form of a cloud set up by aerial attack. We would expect the nature and extent of this cloud to be defined by trained civil defense workers using equipment identical or similar to that employed by the military for detection and identification. Areas contaminated with liquid nerve gas must be clearly marked with warning signs or tapes, since toxic vapor will rise for some time after the actual missile explodes.

Chemical agents might also be used covertly—to contaminate our water or food supplies, for example. Kits have been developed for detection of contaminants in these media, and it is planned to train civil defense public health workers how to use such devices and how to interpret the results.

Defensive Measures

The havoc a gas attack is capable of producing must receive serious consideration in our civil defense planning. Certainly to ignore these weapons would increase our vulnerability. The use of nerve gases against an ill-informed and unprotected public would create hysteria, and panic almost beyond the imagination. Without gas masks or gas-proof shelters, the casualty rate would be enormous.

A gas mask is the only sure protection against nerve gas or any of the other toxic agents that might be used. At the request of the Federal Civil Defense Administration, the Army Chemical Corps is developing an effective gas mask for use by civilians. The result of several years of research, this mask has several new features. No cannister is used, for example. Instead, there is a so-called diffusion board. One breathes through the sides of the mask rather than through a device attached to the sides or bottom. The mask will have to be made in various sizes to accommodate individual faces. The estimated cost is slightly more than $2.

Already available is another type of gas mask, which is the approved model for civil defense workers. It is a heavy duty type, very similar to the military mask, for use by rescue and monitoring personnel.

A device to protect preschool-age children and babies, who cannot be fitted with a gas mask, is being developed.

Poor shelter from a gas attack is afforded by ordinary enclosed spaces, such as rooms or buildings. In fact, the danger may increase in such spaces after the cloud passes, since residual concentrations may be trapped within the enclosure. Both exposure time and concentration of the substance are important factors, particularly for agents, such as the nerve gases, which the body cannot detoxify. The same effect may be produced by halving the concentration and doubling the exposure time, for example.

Sealing off openings and cracks in a shelter will help prevent penetration of the vapors. Group shelters from which contaminated air is excluded by filtering devices are feasible.

In summary, modern chemical weapons are extremely toxic and can be delivered upon critical targets in our country. Their physiological action produces characteristic symptoms at such a rapid rate that recognition of the early symptoms serves as an effective means of detection. Protective equipment can be produced. But, until and unless this equipment is available—and it is not today—the United States presents a most attractive target for mass casualty attack with nerve gas. Postattack therapy is possible but of little value without protection for both casualties and first aid personnel.

Biological Hazards

PHR brief

Civil defense responsibilities in connection with communicable disease control are so closely related to peacetime activities that major differences exist primarily in emphasis. We have made much progress in the continuing battle against communicable diseases. In a disaster, however, conventional protective measures are likely to be impaired. There is also the possibility of deliberate introduction of disease agents, which may be considered as an adaptation, or perversion, of naturally occurring biological attacks.

Thus, the Public Health Service Communicable Disease Center is able to accept its responsibilities in civil defense by extending and increasing its normal operations. This discussion will be directed primarily toward the investigative activities needed to prepare for wartime health emergencies.

Natural Disease Outbreaks

In this country, many of the communicable diseases are held in check by the combined effects of a relatively high standard of living and widely employed public health practices of immunization, water treatment, milk pasteurization, environmental sanitation, and good nutrition. The destruction of shelter, water supply installations, and sanitary facilities, the movement or concentration of large population groups, and the lowering of individual resistance by exposure, inadequate or improper diet, and lack of immunization, all of which may be associated with modern war, could reduce our defenses against disease to a primitive state. Such reduction in our defenses could well be followed by an increase in communicable diseases to epidemic proportions. Hence, we must prepare to maintain as far as possible our present methods of control during wartime, and we must carry on a continuing search for new and more effective procedures.

The center's current program includes developmental studies in the form of laboratory and field research intended to provide new or better methods for control of diseases. As these methods are field tested, they are demonstrated in State and local areas. Training or assistance with training is provided for professional health personnel. Also, equipment and personnel are supplied to communities in the event of epidemics or disasters which cannot be handled by local resources.

Such activities are in the direct interest of our survival during wartime. The needs of civil defense demand that communicable disease research also look at the exotic diseases and the old diseases which may well be revived under emergency conditions. Thus, civil defense requires a communicable disease program broadened to include all likely occurrences and intensified so that each unit of the public health system can operate effectively during emergencies.

One of the problems that may arise in wartime is the exposure of the surviving human population to disease transmitted by rodents and by insects, such as blowflies, which are not ordinarily associated with disease transmission. The development of a chemical treatment for carcasses to prevent both fly breeding and rodent feeding would be the ideal means of solving this problem. Preliminary studies in the Savannah laboratories of CDC have established the potentiality of protecting bodies from blowfly breeding by use of certain pesticides. Plans are being developed for testing additional pesticides and for improving methods and equipment used in the application of these substances against both flies and rodents.

Biological Warfare

Certain diseases which may be of relatively little importance in peacetime could assume great significance in biological warfare. Since the majority of biological warfare victims would be those whom the agent reaches directly, it is imperative to know quickly when, where, and what agent was used. Among the most pressing needs in biological warfare defense,

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therefore, are rapid and effective means of detecting, recovering, and identifying pathogenic organisms in air, water, and foodstuffs—and possibly in the soil.

Because a likely form of biological attack would be through the formation of aerosol clouds containing pathogenic agents, a prime essential of biological warfare defense is the development of methods and equipment to collect these organisms from the air. Ideally, sampling devices should operate on a 24-hour basis. To reduce to a practical minimum the manpower necessary to operate the devices in this fashion, semiautomatic equipment must be developed.

An obvious corollary to improvement in sampling is the need for methods of rapidly identifying organisms which are considered potential biological warfare agents. Serologic methods have shown the greatest promise to date. Ordinary serologic procedures have the disadvantage of requiring fairly large numbers of organisms and hence a period of time for cultivation of the organisms. A current CDC project concerns methods of identifying pathogenic organisms when only small numbers are present. Promising results have been obtained in preliminary studies with fluorescein-tagged antibodies. In this technique, high-titered antiserums, specific for pathogenic organisms which are considered potential biological warfare agents, are developed in laboratory animals. The antiserums are then associated by chemical means with a fluorescent compound. When homologous organisms and fluorescein-tagged antibodies are combined, the organisms will fluoresce under ultraviolet light.

Chemical Warfare

Although communicable disease control would not appear to be directly related to defense against chemical warfare, actually certain principles and activities are parallel. Since 1949, the Communicable Disease Center has been making extensive studies of insecticides, including the organic phosphorus compounds which are chemically related to and produce essentially the same physiological effects as the nerve gases. These studies have included field and laboratory investigations concerned with toxicity of the compounds under varying conditions, detection and prevention of hazards involved in their use, and treatment of workers exposed to them. Much of the information gained is applicable in civil defense against chemical warfare agents.

Supplementary investigations specifically designed to meet civil defense requirements are needed, however. Problems that should be studied include: development of automatic devices and techniques for rapid detection of nerve gases and feasibility of including such equipment as an integral part of the automatic public warning system; inactivation of nerve gas aerosols by means of counteraerosols or smokes containing mild alkali; effectiveness of protective devices and clothing against nerve gases; persistence of toxic substances on foods and surfaces; decontamination techniques for buildings, clothing, and environment; rapid screening for cholinesterase determinations; and treatment of poisoned persons.

Sanitary Engineering

PHR brief Civil defense research activities of the Robert A. Taft Sanitary Engineering Center are of the type for which its facilities and staff are well suited. Progress in the projects assigned late in 1954 is summarized here.

Water Supply Protection

Research concerning protection of water supplies has two primary aims: (*a*) to develop feasible methods of reducing the hazards to water supplies from overt or covert attacks with biological, radiological, and chemical agents and (*b*) to develop methods for supplying safe potable water during emergencies.

The plan for accomplishing the first of these aims calls for:

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1. Evaluation of the hazards to water supply sources of enemy attack with the various special agents.

2. Additional laboratory investigations of the ability of water treatment processes to remove or inactivate various agents.

3. Development of new or improved methods of removing or inactivating these agents.

4. Field trials of the methods developed.

The plan for accomplishing the second aim includes:

1. Determination of needs for emergency water treatment facilities, particularly in areas to which people will be evacuated from target cities.

2. Development of the simplest and least expensive, but reliable, emergency treatment methods.

Several projects already under way are providing valuable information concerning protection of water supplies. One, which is under the sponsorship of the Bureau of Yards and Docks of the Navy, is aimed at developing design criteria and operating instructions for protection of naval continental shore base water supplies from biological, chemical, and radiological agents. We are also studying the ability of existing municipal water treatment methods to remove various concentrations of coliform organisms from raw water; the fate of fallout in the environment after atomic bomb tests; and disinfection materials and techniques. Tentative findings concerning the hazards to water supplies of the various special agents follow.

Biological Agents

A number of biological agents will effectively contaminate water, and the use of these agents by saboteurs is a distinct possibility. Every house connection, every fire hydrant is a possible point of entry by a contaminant. Policing of a large municipal water distribution system to prevent such contamination is out of the question.

The exact quantity of material required to produce an infectious dose of the various biological agents is not known, but it is estimated from limited information on oral infectious doses that 1 to 10 pounds of material would be sufficient to contaminate a million gallons of water. Each cupful of this million gallons would contain an infectious dose.

We see no way of protecting municipal water systems against a determined saboteur. However, we believe that entire cities would not be attacked. It seems more probable that bacterial sabotage would be directed against critical industrial, military, or other particularly vital elements of a city. Re-treatment of water, provision of an auxiliary supply, or storage near the point of use are the only sure means of protecting against such sabotage. Our studies are aimed at determining how much treatment may be needed, whether disinfection alone will suffice, or whether more complete treatment must be provided.

Detection of biological agents in water is likely to be too slow to prevent infection. As yet, too little is known about the normal variation in chlorine residual in municipal distribution systems to warrant use of chlorine residual measurements for monitoring water for presence of contaminants. Visual detection of bacterial contamination is not feasible because of the high concentrations of organisms that would be required.

Knowledge of the ability of water treatment processes to deal with biological contaminants is extremely limited. We know that chlorine in concentrations of less than 1 p.p.m. will deal effectively with contamination by vegetative bacteria if the chlorine is not in a combined form. We know the chlorine requirements for killing the cysts of certain protozoan parasites. But little is known about the ability of water treatment processes to remove viruses or rickettsiae, or the chlorine doses necessary to kill certain spore-forming bacteria, or methods for removing or detoxifying organic toxins.

Chemical Agents

The standard chemical warfare agents are relatively unattractive as intentional water contaminants. The nerve gases, for example, although among the most toxic chemicals known, are considered less of a danger than some of the biological agents. Their toxic effects are exhibited so promptly and so dramatically that their presence would be suspected as soon as a few people had used the water.

Methods for removing nerve gases from wa-

ter have been developed by the Chemical Corps of the Army and tested by the Corps and the Army's Engineer Research and Development Laboratory. These gases hydrolyze readily at high pH values. Hence, in the event of incidental contamination of water supplies as a result of missiles containing chemical agents falling into the water system, adjustment of the pH to about 10 will lead to the hydrolysis of nerve gases to relatively nontoxic products within a comparatively short time. A method for detecting nerve gases has also been developed by the Chemical Corps, and kits for use in detecting these and other chemical agents in water are available.

The possibility exists, of course, that chemical agents unknown to us are available to an enemy. If other materials do become known, it may be necessary to revise our estimate of the hazard of chemical agents to water supplies.

Development of a monitoring device that will detect any chemical agent and perhaps some toxins may be possible. We are now studying the use of fish, which are much more sensitive than humans to toxic chemicals, as detectors.

Radiological Agents

Although radioactive materials are not considered probable intentional contaminants, there are hazards to water supplies from the radioactive fallout produced by an atomic explosion. Thermonuclear weapons may be detonated at levels which give rise to considerable fallout. However, to what extent these weapons will affect water supplies, we are not ready to say. It is certain that the hazards associated with the use of water contaminated by manmade radioactive elements will not decrease as rapidly as the radioactivity in the water decreases, because the most dangerous of the radioisotopes from the standpoint of internal use have relatively long half-lives. Some water sources may remain dangerously contaminated long after external exposure to radiation from fallout on the ground has declined to tolerable levels.

Additional information on the physical and chemical characteristics of the fallout material is needed to help evaluate the hazards to water supplies. The Public Health Service and others have shown that standard water treatment processes are of limited use in removing soluble radioactive materials. The hazardous isotopes, particularly those of strontium, barium, and iodine, do not respond well to standard water treatment processes. If water supplies are heavily contaminated with these materials, and if the elements are not so closely associated with particulate matter as to be removed with the particles, expensive treatment, such as ion exchange or distillation, will be required to restore safety to drinking water.

Food Protection and Decontamination

One of the first problems following an attack with biological, chemical, or nuclear weapons will be to provide safe food to the surviving population. The Public Health Service shares the responsibility for planning to meet this problem with the Department of Agriculture and the Food and Drug Administration. The Public Health Service area of planning includes the protection and sanitation of milk supplies and other foods in retail markets, restaurants, other public places, and in the home.

Research needs fall into four principal categories: (*a*) rapid procedures to distinguish the nature of the contaminant; (*b*) means for preventing or eliminating contamination by biological and chemical aerosols and radioactive fallout; (*c*) practical decontamination procedures for foods; and (*d*) problems of sanitation and emergency storage of foods needed for mass feeding of displaced persons.

Emergency decontamination of other essential items (food containers or packages, eating and drinking utensils, clothing, and bedding) and of the person and the shelter area is also being studied. Under some conditions and for some items, routine cleansing with soapy water may be the most important phase of decontamination. Information will be obtained on the probable kinds, amount, and persistence of contaminants, as well as the effectiveness of available decontaminants under emergency conditions.

Rapid Identification Methods

We are seeking to adapt membrane filter procedures and infrared spectrophotometry for use

in the rapid isolation and identification of bacteriological agents from mixed bacterial populations.

When dried smears of bacterial cells are subjected to infrared spectrophotometry (wave length 5μ to 12μ), characteristic and identifying spectra are obtained. The characteristic absorptions are reproducible within plus or minus 2 percent, provided the bacterial cells are grown under carefully controlled conditions and provided the infrared spectrophotometer is carefully set, balanced, and operated. The spectrographic data can be transferred to punch cards and identification readily established by matching unknowns with knowns. The procedure can be accomplished within a few hours after sufficient bacterial cells are available. At the present time, about 1 mg. of cells is required, but recent developments indicate that satisfactory spectra may be obtained on as little as 0.1 or possibly 0.01 mg. of cells.

Bacterial cells grow on the membrane filter in 10 to 20 hours. The time required depends on the specific organism and other factors. Because the filter is an efficient means of concentrating the organisms from dilute suspensions in fluid or gaseous menstrua and because the organisms grow in situ, membrane filter procedures offer time advantages over conventional fluid or agar media in the production of pure colony growths from mixed populations. By transfer of single colony growths to standard medium, followed by 6- to 8-hour incubations, sufficient pure culture cells for infrared spectrophotometry become available.

We believe that, by using a relatively few (4 to 6) basic differential media, the potential bacterial pathogens can be grown on the membrane filter and tentatively differentiated from nonpathogenic species. Incubation of suspicious colonies on a standard medium for a few hours will supply sufficient cells to allow completion of identification by infrared spectrophotometry. We believe this procedure is capable of detecting and identifying pathogens present in relatively small numbers, even when they are mixed with relatively large numbers of nonpathogenic organisms. The entire process of detection, isolation, and identification could take less than 30 hours.

The available information regarding the detection and identification of chemical agents is being reviewed, with emphasis on the nerve, cyanogenous, mustard, and arsenical gases.

PHS Responsibilities

PHR brief

Prompted by the reasoning that public health phases of civil defense should be "built in" with existing public health programs, the Federal Civil Defense Administration delegated public health civil defense responsibilities to the Department of Health, Education, and Welfare on July 14, 1954. It was felt that the Public Health Service could carry out these responsibilities efficiently and economically through well-established channels. It was recognized, further, that civil defense will be a long-range activity and that it therefore requires continuing program attention.

The following functions have been assigned to the Public Health Service:

1. Plan a national program, develop technical guidance for the States, and direct Federal civil defense activities concerned with research relating to the detection, identification, and control of: (*a*) communicable diseases in man, (*b*) biological warfare against man, (*c*) chemical warfare against man, and (*d*) other public health hazards.

2. Plan, develop, and direct Federal activities concerned with a national program designed to provide Public Health Service reserve personnel from support areas to areas damaged by enemy attack.

3. Plan, develop, and distribute, through appropriate channels, technical guidance concerning the provision of shelter and other protective measures designed to minimize injury to personnel and to reduce damage to vital functional components of public health facilities.

4. Plan a national program, develop technical guidance for States, and direct Federal

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activities concerned with emergency restoration of community facilities essential to health or functional components thereof for which the Public Health Service normally has operating programs.

Planning Assumptions

The Public Health Service civil defense work program for fiscal year 1955 was based on the FCDA planning assumptions for that year. The highlights of these assumptions are:

1. An enemy has the capability of striking any target in the United States.
2. Such attack, if it comes, will consist principally of nuclear (including thermonuclear) weapons delivered by air. These weapons might be delivered by submarines, or they might be smuggled in.
3. Additional weapons, requiring special measures to meet large-scale attacks, will be biological and chemical agents.
4. High-explosive and incendiary bombs are also possible weapons.
5. Preparation must be made to meet psychological warfare and sabotage. Sabotage may include attempts to disrupt industries and communications and covert attacks with biological and chemical agents.
6. The initial attack will be in the nature of an attempted knockout blow, but recurring attacks may be expected.
7. The size of the bombs will range from a few thousand tons to millions of tons of TNT equivalent. One bomb will be sufficient to destroy the largest city.
8. Approximately 1 hour's warning will be received in most areas—possibly less time in some coastal areas and more time in inland areas.
9. Mass evacuation of target cities will provide the best means of reducing casualties.
10. Any area attacked will require outside support; mutual aid will be helpful but it will not be sufficient alone. Both mobile and fixed support from the State attacked, other States, and Federal sources will be required.

We understand that many of the 1955 assumptions, such as the probability that biological and chemical weapons, as well as nuclear weapons, will be used against us, will be carried over to the planning assumptions for fiscal year 1956. However, a major change is expected as a result of the recent Atomic Energy Commission release concerning radioactive fallout from explosion of a thermonuclear bomb. The release emphasized that it is not possible to apply a single fallout pattern to all thermonuclear detonations. This is true even under test conditions, when the bomb size is known, since the nature of the ground where the explosion occurs, the size of the resulting particles, and the variable directions and velocities of the winds at different levels all have to be considered. With adequate knowledge of atmospheric conditions, however, the fallout pattern usually can be predicted with considerable accuracy.

In the Bikini test of March 1954, the area of extreme hazard from fallout was up to 20 miles wide and 140 miles long downwind from the explosion and about 20 miles upwind and crosswind. The area of some hazard extended approximately 100 miles farther downwind and 20 miles farther to the sides.

Outline of the PHS Program

The Office of the Surgeon General has the overall responsibility for civil defense planning and program development in the Public Health Service. In addition, this office is conducting a project concerning the adaptability of military chemical warfare defenses to civil defense needs.

The National Institutes of Health are conducting investigations designed to lead to improvement of vaccines and other immunizing procedures. Some of their research is directed toward the development of better adjuvants and the determination of effects of known adjuvants with different vaccines. They are also studying preparation and evaluation of purified antigens in experimental animals and the effects of combined antigens in reduced amounts. The goal for this year is to determine whether or not combinations of certain antigens will produce adequate immunization in experimental animals and the minimum amounts that will produce satisfactory immunity. (Since the date of the civil defense conferences, this work has been suspended temporarily.)

The Bureau of State Services will keep the

States informed of the results and means of application of all research relating to biological and chemical warfare hazards and other public health problems. Upon request from the States, the Bureau will provide training courses for key health personnel and for trainers, who, in turn, can train others. To the limit of its resources, the Bureau will provide assistance in planning State studies and operations. The Public Health Service regional offices will be the channel between the Public Health Service and the States.

Glossary of Radiation Terms

Alpha particle: Charged particle, having a mass of 4 units and 2 unit positive charges of electricity, which is emitted from the nucleus of some atoms. It is composed of 2 neutrons and 2 protons.

Alpha ray: Stream of fast-moving alpha particles. It is a strongly ionizing and weakly penetrating radiation.

Atom: The chemical unit of which all matter is made. It is the smallest particle of an element capable of entering into a chemical reaction.

Atomic radiation: Radiation produced by energy changes in atomic nuclei or atomic electron clouds; ionizing radiation.

Background radiation: Ionizing radiation produced by cosmic radiation and naturally occurring trace amounts of radioactive elements.

Beta particle: Charged particle, having a mass and charge equal in magnitude to those of the electron, which is emitted from the nucleus of some atoms.

Curie: Standard measure of the rate of radioactive decay; the quantity of any radioactive substance in which the number of disintegrations per second is 3.7×10^{10}. The radioactivity of 1 curie of a substance is comparable to the radioactivity of 1 gram of radium.

Decay: Disintegration of the atomic nucleus of an unstable element by the spontaneous emission of charged particles or protons or both.

Electron: Negatively charged particle which is a constituent of every atom; unit of negative electricity equal to 4.80×10^{-10} electrostatic units. Its mass is about $\frac{1}{2000}$ of that of a proton.

Electron volt: Amount of energy gained by an electron in passing across a potential difference of 1 volt.

Equivalent roentgen: Amount of radiation which produces in air an amount of ionization equal to that produced by 1 roentgen of X-radiation or gamma radiation.

External radiation: Radiation entering the body from without.

Fallout (radioactive or atomic): The radioactive dust and atomic or hydrogen bomb debris that falls to the ground downwind from an atomic explosion.

Film badge: Small piece of X-ray or similar photographic film enclosed in a lightproof paper, usually crossed by lead or cadmium strips, carried in a small metal or plastic frame. It is used to estimate the amount of radiation to which an individual has been exposed.

Gamma ray: Electromagnetic radiation emitted from the nucleus of a radioactive atom.

Half-life: Time required for a radioactive substance to lose by decay 50 percent of its activity.

Internal radiation: Radiation produced inside the body from a radioactive substance assimilated and contained within the tissues.

Ion: Atomic particle, atom, or chemical radical (group of chemically combined atoms) bearing either a positive or negative electrical charge caused by an excess or deficiency of electrons.

Ionization: Act or result of any process by which a neutral atom or molecule acquires either a positive or negative electric charge.

Ionizing radiation: Radiation possessing sufficient energy to ionize the atoms or molecules absorbing it.

Isotope: Any of two or more forms of an element having the same atomic number (nuclear charge) and hence occupying the same position in the periodic table. All isotopes of an element are identical in chemical behavior but are distinguishable by small differences in atomic weight. The nuclei of all isotopes of an element have the same number of protons but differ in the number of neutrons.

LD_{50}: The dose of radiation which will cause death to approximately 50 percent of the members of a given animal species, usually within 30 days; the median lethal dose of radiation.

Mass unit: Unit of mass which is $\frac{1}{16}$ the mass of an oxygen atom taken as 16.00000.

Maximum permissible dose: The maximum dose of ionizing radiation that, in the light of the present knowledge, is not expected to cause appreciable bodily injury to a person at any time during his life.

Microcurie: A millionth of a curie; the quantity of any radioactive substance in which the number of disintegrations per second is 37,000.

Millicurie: A thousandth of a curie.

Neutron: Nuclear particle which is electrically neutral. Its mass is approximately the same as that of a proton.

Nuclear reactor: A device or machine for producing energy by fission or fusion of atomic nuclei.

Permissible dose: A dose of ionizing radiation that, in the light of present knowledge, is not expected to cause appreciable bodily injury to a person in any time during his life.

Proton: Nuclear particle with a positive electric charge equal numerically to the charge of the electron. Its mass is 1.007575 mass units.

Radiation sickness: The group of symptoms developed consequent to an overexposure to ionizing radiation. The symptoms include weakness, nausea, vomiting, diarrhea, leukocytopenia, anemia, and spontaneous bleeding.

Radioactivity: Characteristic of certain kinds of matter, the atomic nuclei of which are unstable and undergo spontaneous disintegration with liberation of energy. The disintegration process, which usually results in the formation of new elements, is accompanied by the emission of one or more types of radiation, such as alpha particles, beta particles, and gamma rays.

Radiosotope: A radioactive isotope.

Radiological health: The public health aspects of the use of ionizing radiation.

SD_{50}: The dose of radiation which will cause radiation sickness to approximately 50 percent of the members of a given animal species.

Approval Withdrawn for Three Food Dyes

The Food and Drug Administration has removed three widely used coal tar dyes from the certification list of approved coloring materials which may be added to food. The law requires that food colors be certified as completely harmless.

The three colors involved, FD & C Orange No. 1, Orange No. 2, and Red No. 32, are harmless in the amounts ordinarily consumed in foods, but recent scientific investigation shows they are not harmless when taken in large amounts.

Orange No. 1 has been widely used in candy, cakes, cookies, carbonated beverages, desserts, and meat products, especially frankfurters. Orange No. 2 and Red No. 32 have been used in coloring the outer skin of oranges.

While manufacturers may no longer label and sell these three colors for food use, all three colors have been added to the list that may be certified for external drug and cosmetic use.

These colors will no longer be certified for internal use after February 14, 1956. The law does not prevent use of stocks previously certified.

Tuberculosis Morbidity and Mortality Facts and Trends

By ROBERT J. ANDERSON, M.D.

THE IMPACT of tuberculosis on our population has undergone remarkable changes in the recent past. Deaths from tuberculosis continue to decline, and illness is somewhat less frequent and of shorter duration. Current facts and trends may make clear some of the directions effort must take to accomplish a continuing control of tuberculosis.

The complexity of morbidity reporting limits good detailed data on the subject to recent years. Mortality data, however, being simpler to collect if not as rich in meaning, are available in much longer series and much more detail.

The number of deaths (fig. 1) from tuberculosis has declined between 15 percent and 20 percent each year for the last few years. In spite of this decline, provisional tabulations show that for 1954 there were 17,000 deaths from tuberculosis in the United States, a rate of 10.5 per 100,000 population. For the first quarter of 1955, the decline appears to be somewhat retarded, with a death rate about 10 percent less than that in the first quarter of 1954.

Deaths measure only one aspect, though an important one, of the impact of tuberculosis upon our population. The death rate has never been a precise index of the trend of the tuberculosis problem, and today its usefulness is more limited than in former years. But, in recognizing the limitations of mortality as an index of trends, its usefulness as an indication of the relative influence of the disease on various population groups should not be ignored.

Dr. Anderson, assistant chief for operational research, Division of Special Health Services, Public Health Service, presented this paper at the annual meeting of the National Tuberculosis Association, held at Milwaukee, May 26, 1955.

The number of new cases reported now constitutes one of the best indexes of the trend of tuberculosis although a decade ago reporting was so inadequate in many places as to make this measure virtually useless. In the last several years there has been approximately a 3 percent decline in the number of new cases reported per year. At this rate, more than a quarter century will be required to equal the same percent reduction realized in mortality in the last 5 years alone. The prospect of even this achievement is beclouded by one recent observation. Preliminary morbidity reports for the first 3 or 4 months of 1955 from two-thirds of the United States show an increase of 2 percent in new tuberculosis cases. A portion of this increase may be due to additional case finding. There is need for further study to determine whether there are other reasons for the increase.

Tuberculous Meningitis

Tuberculous meningitis, not to be compared with respiratory tuberculosis in the number of lives it has taken, has nevertheless been an important index of the degree of control of the

whole tuberculosis problem. A low tuberculous meningitis death rate has been considered an index of success in preventing the spread of the tubercle bacillus. Two-thirds of such deaths occur among children under 15. From 1900 to 1920, there was little decline in tuberculous meningitis death rates. From 1920 to 1940, the drop was almost precipitous, as compared with the gradual decline in respiratory tuberculosis rates. This was about the time when the number of tuberculosis beds began to climb. It was a matter of considerable concern that from 1944 to 1950 there was a leveling off in the number of deaths due to tuberculous meningitis. Fortunately, there has been a substantial decline in the last 3 years, doubtless because of improved techniques of present-day drug therapy.

Now that the case-fatality rate for tuberculous meningitis has been dramatically reduced, this death rate is no longer a useful index of the adequacy of a tuberculosis control program. Accurate data on the incidence of tuberculous meningitis, however, would still be a useful index for that purpose.

Age, Sex, and Race

Tuberculosis as a disease is still very much a foe of young adults (fig. 2). Although the rate is low in children, it rises sharply in the 15- to 24-year age group and continues to increase gradually with age. For the entire United States half of the newly reported active cases are patients under 42 years of age. Thus the frequency of the disease among young adults who respond very favorably to present-day drug therapy is a matter of significance for tuberculosis program planning.

Figure 1. Newly reported tuberculosis cases and tuberculosis deaths, United States, 1930–54.

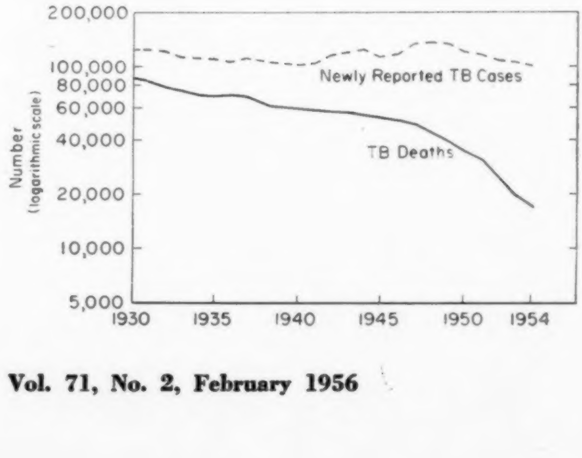


Figure 2. Age-specific rates for newly reported active and probably active tuberculosis cases and tuberculosis deaths, United States, 1953.

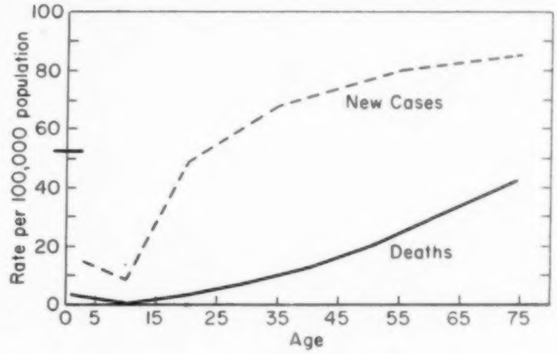
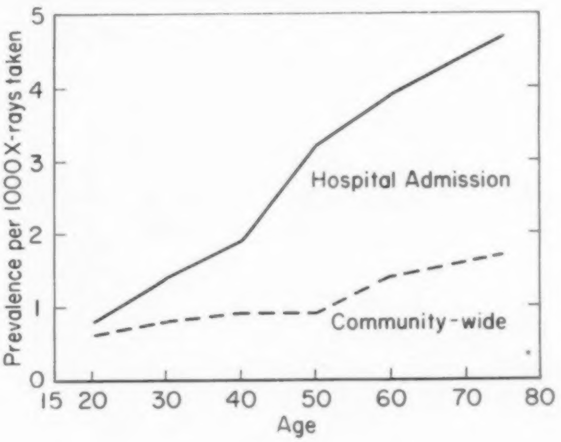


Figure 3. Active tuberculosis cases per 1,000 X-rays taken in communitywide and hospital admission X-ray programs.



While a large proportion of all tuberculosis cases are reported among the younger part of our population, the case rates are higher in the older age groups. Moreover, the rates of newly reported tuberculosis cases for older people show little decline from year to year. In fact, in the age 65 and over group, a slight increase was shown for 1953. High morbidity rates for those in the older age groups are also found in communitywide surveys and in hospital admissions X-ray screening programs (fig. 3).

In the past half century (fig. 4) the decline in tuberculosis mortality by age has been most marked in infants under 1 year of age. In the first decade of the century, infants under 1 year of age had a higher tuberculosis death rate than

any other age group. In recent years this group has had a lower death rate than has any of the adult age groups.

From 1930 to 1950, there was relatively little drop in tuberculosis death rates in the older age groups, but in the last few years, the decline has been quite marked. Even more rapid has been the decline in death rates for those under 25.

Rates of newly reported active cases of tuberculosis by sex and race continue to demonstrate somewhat the same pattern as in former years. Rates for white males are approximately twice those for white females. Rates for nonwhites are approximately three times as high as for whites. Yet, in six States, the tuberculosis case rates are higher for white males than for nonwhite females, and further, the number of cases reported for white males (fig. 5) is almost as great as the number for the other three groups combined.

The proportionate decline in death rates has been much greater in recent years among fe-

Figure 4. Age-specific tuberculosis death rates, United States, 1900–1953.

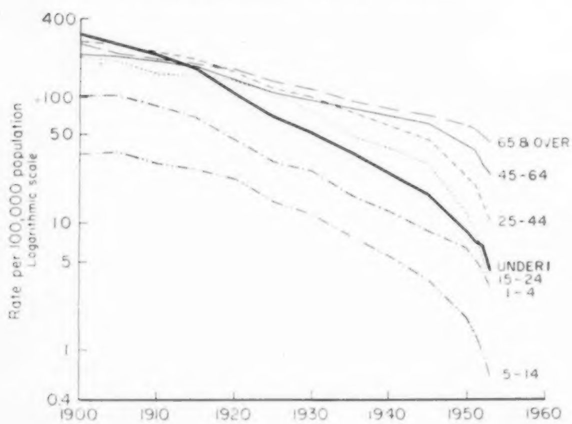


Figure 5. Race and sex of newly reported active and probably active tuberculosis cases, United States, 1953.

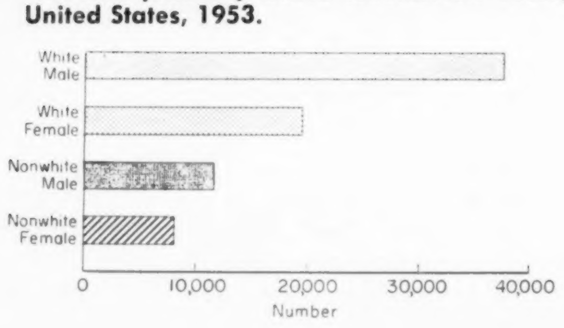


Figure 6. Race and sex-specific tuberculosis death rates, United States, 1940–54.

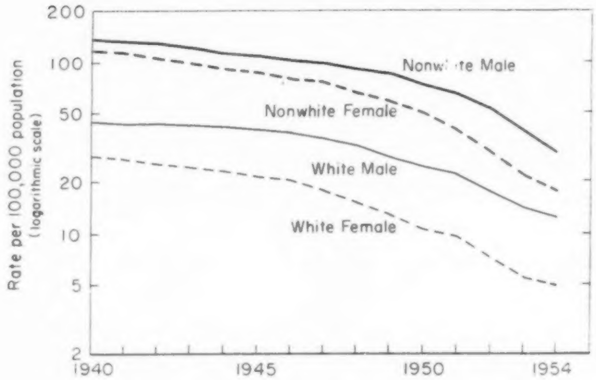
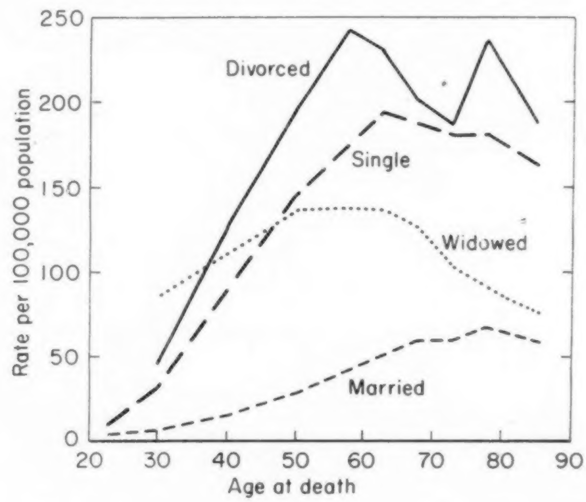


Figure 7. Marital status, age-specific tuberculosis death rates for white males, United States, 1949–51 average.



males than among males (fig. 6). If this trend continues for another 5 years, white males will have a higher tuberculosis death rate than nonwhite females.

Marital and Economic Status

Generally, death rates from all causes are definitely higher for the unattached than for the married (fig. 7). Tuberculosis death rates are much higher for single, widowed, and divorced people than for married persons.

The close relationship between tuberculosis mortality and economic status has been generally recognized. However, when the prevalence of unreported tuberculosis in terms of

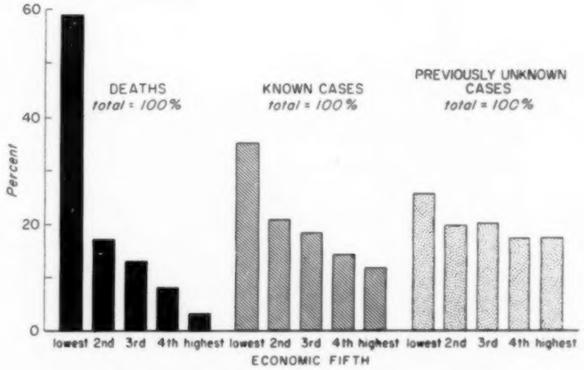
economic status is examined, this relationship is not so marked. For example, in a study made in Cleveland, Ohio, it was learned that tuberculosis mortality was almost 20 times as great in the lowest economic group as in the highest (fig. 8). However, previously unknown tuberculosis cases in the lowest economic group were only about 1.5 times as great as in the highest. It seems reasonable, therefore, to conclude that low economic status and tuberculosis each tend to beget the other.

This suggests the need for study of the social, psychological, economic, and nutritional factors which have been recognized as being important in the development of tuberculosis. It also suggests the need for directing case-finding activities. It is not sufficient to search for cases among the population groups which have the highest death rates. It is better to search among the groups with the highest prevalence rates, but undue emphasis may result in missing the large number of cases in those groups that have lower prevalence rates but large numbers of people.

Geographic Distribution

Tuberculosis death rates generally are high in the large cities. Cities of 100,000 population and over have a tuberculosis death rate approximately 80 percent higher than that of the remainder of the country. In fact, when the death rates for each State, exclusive of the large cities, are computed, there are only four States—Arizona, Tennessee, Arkansas, and Kentucky—which have death rates higher than the average

Figure 8. Percentage distribution of deaths from tuberculosis, known cases and previously unknown cases, by economic fifth, Cuyahoga County, Ohio.



rate for the large cities. Maryland is one of the States with a fairly high tuberculosis death rate, yet, when Baltimore is excluded, its death rate in 1953 was below 10 per 100,000 population. Maryland exclusive of Baltimore has a lower rate than do any of the States nearby with their large cities excluded. When the large cities in Michigan, Wisconsin, and Minnesota are excluded, those States compare quite favorably with the other middle western States and the Mountain States exclusive of large cities. People who live in the suburbs have a death rate less than half the rates in the large cities. Small cities, unincorporated urban areas, and rural areas have the lowest rates.

Morbidity rates are lowest in some of the States in the western plains and Rocky Mountains. A fairly close parallel exists between reported cases and deaths by States (figs. 9 and 10). The decline in mortality has been without any apparent geographic pattern (fig. 11). Some States which had low tuberculosis death rates in 1947 also had the least percentage decline, while other States with moderately low death rates showed the greatest improvement. A similar variation in decline occurred in the group of States with high death rates.

Case Finding and Reporting

The relative slowness with which the rate of newly reported cases has declined has been the object of considerable curiosity. Reporting was very inadequate in many States before 1947, and during the period 1947 to 1949 morbidity reporting was inflated by the inclusion of cases of borderline clinical significance. For recent years, however, rates of newly reported cases are generally not inflated. The evidence for this is twofold: First, approximately 37 percent of new active cases had positive sputum at the time of report; second, 78 percent of the cases were reported as either moderately advanced or far advanced. There is no appreciable change from the preceding decade.

Further evidence of the persistently high incidence of tuberculosis is in the number of admissions to tuberculosis hospitals. These have done little more than fluctuate in the period from 1947 to 1953 in several large States for which data are available. Vacancies in beds are

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Figure 9. Newly reported active and probably active tuberculosis cases per 100,000 population (provisional data), United States and Territories, 1954.

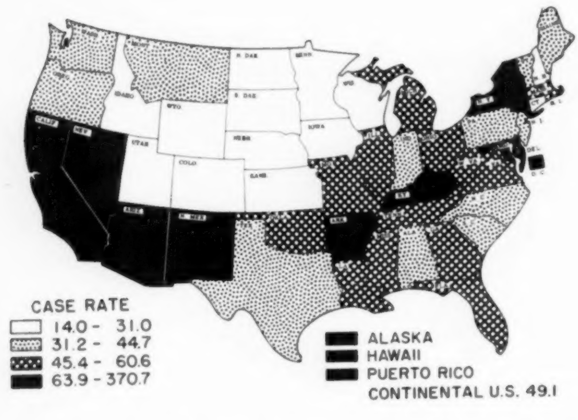
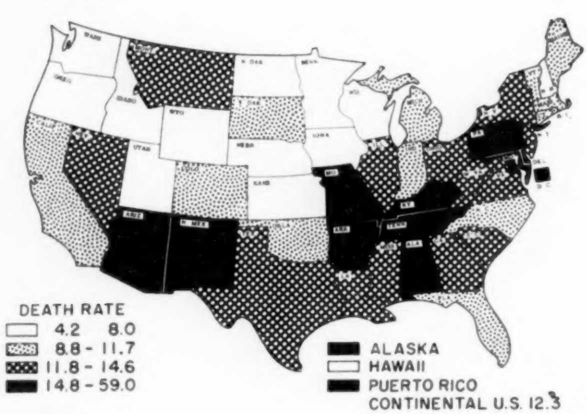


Figure 10. Tuberculosis deaths per 100,000 population, United States and Territories, 1953.



probably due more to reductions in duration of stay than to decreases in admissions.

Tuberculosis case finding and reporting now are definitely superior to that of previous decades. For example, almost one-third of reported cases are found by X-ray survey. Fewer cases are first reported by death certificate. Even now, however, more than one-fourth of tuberculosis deaths were never reported as living cases. Large numbers of cases are not reported until the report of the sanatorium admission is received by the health department. The number of cases that remain unreported because they are not referred for sanatorium admission is not known. While progress has been made in reducing the proportion of cases first reported in the far-advanced stage to 37 percent, it would seem reasonable to expect a further movement of reported cases from the far-advanced category to the moderately advanced category provided case-finding and case-reporting efforts are not relaxed.

Usually cases are diagnosed as tuberculous before they are referred for hospitalization, and in such instances the cases should be reported to the health department by some source other than the tuberculosis sanatorium. Even so, in 10 States, 40 to 60 percent of the reports of new active cases come from the sanatorium. It is at least questionable that the reporting systems in these States are adequate. In any event, the reporting of cases should be evaluated in the light of the specific practices in any given area.

To find as many cases in early stages of the disease as possible is a most worthwhile and desirable goal, but it is questionable that early case finding can be judged solely in terms of the proportion of new cases which are minimal in extent. The duration of time in which tuberculosis may progress from minimal to advanced may be very short, and present-day diagnostic procedures are such that it is difficult to discover active cases before they become moderately advanced. In order to prove tuberculosis by demonstration of tubercle bacilli from sputum, or gastric or bronchial lavage, necrosis of the lung must have set in, which means that a cavity is being formed. When a cavity can be seen on an X-ray, the case is no longer minimal in extent but must be classified at least as moderately advanced. Obviously, this frequently

Figure 11. Percentage decline in tuberculosis deaths per 100,000 population, United States and Territories, 1947–53.

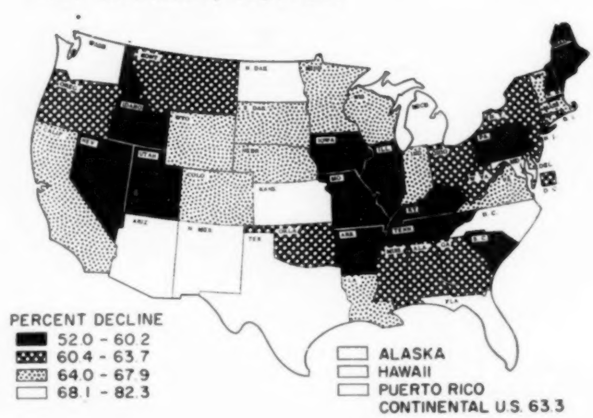
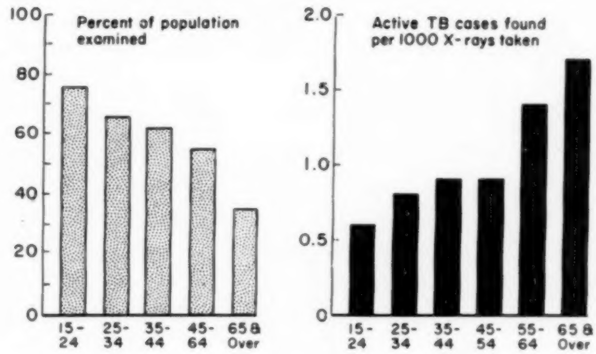


Figure 12. The age groups with the most tuberculosis not reached in communitywide chest X-ray surveys.



leaves a fine line between minimal and moderately advanced disease.

With the emphasis upon reporting active and probably active cases, there is a built-in bias against the reporting of minimal tuberculosis cases. From a practical viewpoint, treatment is not recommended for the minimal inactive cases.

In spite of the difficulties of diagnosing tuberculosis before it has extended, it is still the responsibility of tuberculosis control workers to put forth all possible efforts to use effectively the presently available means for diagnosis. For example, communitywide surveys and other X-ray case-finding programs have generally been successful in the various States, and many millions of people have been X-rayed. However, the surveys have not been as successful as might have been hoped (fig. 12). The older age groups in which the rate of active tuberculosis is greatest have not been adequately covered.

Prevalence

Current information indicates that there are somewhat less than 400,000 active tuberculosis cases in the United States at any one time, approximately one-third of which are hospitalized for tuberculosis, one-third are known cases at home, and one-third are undetected cases.

Several studies in progress indicate that the total number of known active cases is definitely declining. How great this decline is cannot now be accurately measured; but some precise information is available concerning known tuberculosis cases hospitalized at any one time, or the beds the patients occupy. On April 1, 1954, there were 2 percent fewer patients hospitalized for tuberculosis than a year earlier. A study by the National Tuberculosis Association and the Public Health Service, in November 1954, of a large number of tuberculosis hospitals shows a further decline of 6.7 percent. However, the number of patients hospitalized for tuberculosis in November 1954 was greater than at any time prior to 1950.

The number of known active cases at home appears to be declining. Before the days of chemotherapy, the majority of patients discharged from sanatoriums continued to have active disease at home for a substantial period of time. Today, most patients discharged from the sanatorium are discharged with arrested or inactive disease. A substantial proportion of these patients continue to receive chemotherapy at home for a period of months or years after sanatorium discharge. Thus, even though the number of known active cases at home may be declining, the demands upon health department services are actually increasing. These cases, arrested but continuing on drug therapy, will actually require more public health supervision from health department staffs, public health nurses in particular, than corresponding patients received a decade ago. Current studies show a very marked inadequacy of public health supervision and treatment of the known tuberculosis cases who are at home. Although the prevalence of tuberculosis in unattached males, migrants, and other special groups presents a challenging problem, there are numerically more known tuberculosis cases at home in other categories who are not getting control services.

Infection Rates

The number of persons infected with tubercle bacilli is not known. Relatively little of the tuberculin testing now being done provides adequate information concerning infection rates. Several studies are in process and are being planned for this purpose. One such study in the District of Columbia shows an infection rate of only 3 percent for 7-year-old children of all races combined. It is certain, however, that

there are millions of individuals in the United States today, possibly 50 million, who are infected with tubercle bacilli. It is necessary, however, to learn more about the changes which are occurring in new tuberculous infections in the many social, biological, and geographic segments of our population.

Looking Forward

It is hazardous to risk predictions of trends in any field, particularly in tuberculosis. Yet the future is a lure difficult to resist. So marked has been the decline in the death rate of tuberculosis in the past 10 years that to many its disappearance as a public health problem seems an eventuality of an immediate tomorrow. Such optimism is a trap into which even the most guarded minds have fallen, and from them frequently comes the question, "How much longer shall we continue to exert tuberculosis control efforts?"

Despite the unreality of setting an end point for tuberculosis as a public health challenge, an intermediate goal can arbitrarily be selected for the sake of argument, and time limits can be drawn to emphasize the continuing magnitude of the problem.

Even in terms of death rates alone the future task is large and prolonged. It will require years of effort to achieve a death rate of only 1.5 per 100,00 population, which is about the current death rate from acute rheumatic fever, appendicitis, arthritis, poliomyelitis, and several other diseases which are still considered to be of public health import. The maternal mortality rate is about at that level. Measles, whooping cough, and infectious hepatitis combined do not exceed it. When the death rate from tuberculosis drops to the level of these important diseases, then tuberculosis control programs and needs should be reexamined.

Indeed, if conditions remain the same, and if control activities are so maintained that the rate of decline in mortality will equal that of the past 5 years:

It will be 11 years before the crude tuberculosis death rate is 1.5 per 100,000 population; 7 years before this death rate is achieved for white females; between 10 and 15 years, for nonwhite males and females, and white males; and 25 years before the age group over 65 has a death rate of 1.5 per 100,000 population.

The task of defeating tuberculosis is plainly not done. Persisting cases of tuberculosis, especially those out of hospitals, challenge every ingenuity in planning the content and scope of control programs of tomorrow.

Armed Services Medical and Dental Symposium

A 3-day symposium, sponsored by the First Naval District, Boston, Mass., on developments in military medicine and dentistry with special emphasis on atomic warfare, special weapons, and isotopes has been scheduled for March 21–23, 1956.

The first meeting will be held at the United States Naval Hospital, Chelsea, Mass. On the mornings of the second and third days, clinics will be scheduled at various hospitals in Boston on the treatment of disease with radioactive isotopes. Afternoon lectures will be given at the Jimmy Fund Foundation Building and at the New England Deaconess Hospital.

Programs and additional information may be obtained from the District Medical Officer, First Naval District, 495 Summer Street, Boston 10, Mass.

Adopted at the Seventeenth Annual Meeting of the American Conference of Governmental Industrial Hygienists, Buffalo, April 24–28, 1955

Threshold Limit Values for 1955

Values are given in the following tabulation for the maximum average atmospheric concentration of contaminants to which workers may be exposed for an 8-hour working day without injury to health.

These values are based on the best available information from industrial experience, from experimental studies, and, when possible, from a combination of the two. They are not fixed values but are reviewed annually by the Committee on Threshold Limits of the American Conference of Governmental Industrial Hygienists for changes, revisions, or additions as further information becomes available. Threshold limits should be used as guides in the control of health hazards and should not be regarded as fine lines between safe and dangerous concentrations. They represent conditions only within which it is felt that workers may be repeatedly exposed, day after day, without their health being adversely affected. It is felt, at the present time, that workers should not be exposed to a working environment containing any of these substances in excess of the value indicated.

These values are not intended for use, or for modification for use, in the evaluation or control of community air pollution or air pollution nuisances.

Members of the Committee on Threshold Limits of the American Conference of Governmental Industrial Hygienists are: Allan L. Coleman, chairman, William L. Ball, L. T. Fairhall, Kingsley Kay, H. E. Stokinger, A. J. Vorwald, and Louis F. Weller.

ESTABLISHED VALUES

Gases and Vapors

SUBSTANCE	P.P.M.
Acetaldehyde	200
Acetic acid	10
Acetic anhydride	5
Acetone	1,000
Acrolein	0.5
Acrylonitrile	20
Ammonia	100
Amyl acetate	200
Amyl alcohol (isoamyl alcohol)	100
Aniline	5
Arsine	0.05
Benzene (benzol)	35
Bromine	1
Butadiene (1,3-butadiene)	1,000
Butanone (methyl ethyl ketone)	250
Butyl acetate (*n*-butyl acetate)	200
Butyl alcohol (*n*-butanol)	100
Butyl cellosolve (2-butoxyethanol)	200
Carbon dioxide	5,000
Carbon disulfide	20
Carbon monoxide	100

P.P.M.=parts of vapor or gas per million parts of air, by volume.

SUBSTANCE	P.P.M.
Carbon tetrachloride	25
Cellosolve (2-ethoxyethanol)	200
Cellosolve acetate (hydroxyethyl acetate)	100
Chlorine	1
Chlorobenzene (monochlorobenzene)	75
Chloroform (trichloromethane)	100
1-Chloro-1-nitropropane	20
Chloroprene (2-chlorobutadiene)	25
Cresol (all isomers)	5
Cyclohexane	400
Cyclohexanol	100
Cyclohexanone	100
Cyclohexene	400
Cyclopropane	400
o-Dichlorobenzene	50
Dichlorodifluoromethane	1,000
1,1-Dichloroethane	100
1,2-Dichloroethylene	200
Dichloroethyl ether	15
Dichloromonofluoromethane	1,000
1,1-Dichloro-1-nitroethane	10
Dichlorotetrafluoroethane	1,000
Diethylamine	25
Dimethylaniline (N-dimethylaniline)	5
Dimethylsulfate	1
Dioxane (diethylene dioxide)	100

SUBSTANCE	P.P.M.
Ethyl acetate	400
Ethyl alcohol (ethanol)	1,000
Ethylamine	25
Ethyl benzene	200
Ethyl bromide	200
Ethyl chloride	1,000
Ethyl ether	400
Ethyl formate	100
Ethyl silicate	100
Ethylene chlorohydrin	5
Ethylene dibromide (1,2-dibromoethane)	25
Ethylene dichloride (1,2-dichloroethane)	100
Ethylene oxide	100
Fluorine	0.1
Fluorotrichloromethane	1,000
Formaldehyde	5
Gasoline	500
Heptane (*n*-heptane)	500
Hexane (*n*-hexane)	500
Hexanone (methyl butyl ketone)	100
Hexone (methyl isobutyl ketone)	100
Hydrogen chloride	5
Hydrogen cyanide	10
Hydrogen fluoride	3
Hydrogen selenide	0.05
Hydrogen sulfide	20
Iodine	1
Isophorone	25
Mesityl oxide	50
Methyl acetate	200
Methyl alcohol (methanol)	200
Methyl bromide	20
Methyl cellosolve (methoxyethanol)	25
Methyl cellosolve acetate (ethylene glycol monomethyl ether acetate)	25
Methyl chloride	100
Methylal (dimethoxymethane)	1,000
Methyl chloroform (1,1,1-trichloroethane)	500
Methylcyclohexane	500
Methylcyclohexanol	100
Methylcyclohexanone	100
Methyl formate	100
Methylene chloride (dichloromethane)	500
Naphtha (coal tar)	200
Naphtha (petroleum)	500
Nickel carbonyl	0.001
Nitrobenzene	1
Nitroethane	100
Nitrogen dioxide	5
Nitroglycerin	0.5
Nitromethane	100
2-Nitropropane	50
Nitrotoluene	5
Octane	500
Ozone	0.1
Pentane	1,000
Pentanone (methyl propyl ketone)	200
Perchlorethylene (tetrachloroethylene)	200
Phenol	5
Phosgene (carbonyl chloride)	1
Phosphine	0.05
Phosphorus trichloride	0.5
Propyl acetate	200
Propyl alcohol (isopropyl alcohol)	400
Propyl ether (isopropyl ether)	500
Propylene dichloride (1,2-dichloropropane)	75
Stibine	0.1
Stoddard solvent	500
Styrene monomer (phenyl ethylene)	200
Sulfur monochloride	1
Sulfur dioxide	10
1,1,2,2-Tetrachloroethane	5
Toluene	200
o-Toluidine	5
Trichloroethylene	200
Turpentine	100
Vinyl chloride (chloroethene)	500
Xylene	200

Toxic Dusts, Fumes, and Mists

SUBSTANCE	MG. PER CU. M.
Antimony	0.5
Arsenic	0.5
Barium (soluble compounds)	0.5
Cadmium	0.1
Chlorodiphenyl	1
Chromic acid and chromates as CrO_3	0.1
Cyanide as CN	5
Dinitrotoluene	1.5
Dinitro-*o*-cresol	0.2
Fluoride	2.5
Iron oxide fume	15
Lead	0.15
Magnesium oxide fume	15
Manganese	6
Mercury	0.1
Parathion (O,O-Diethyl-O-*p*-nitrophenyl thiophosphate)	0.1
Pentachloronaphthalene	0.5
Pentachlorophenol	0.5
Phosphorus (yellow)	0.1
Phosphorus pentachloride	1
Phosphorus pentasulfide	1
Selenium compounds (as Se)	0.1
Sulfuric acid	1
Tellurium	0.1
Tetryl (2,4,6-trinitrophenyl-methylnitramine)	1.5
Trichloronaphthalene	5
Trinitrotoluene	1.5
Uranium (soluble compounds)	0.05
Uranium (insoluble compounds)	0.25
Zinc oxide fumes	15

RADIOACTIVITY: For permissible concentrations of radioisotopes in air see Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water, handbook 52, U. S. Department of Commerce, National Bureau of Standards, March 1953. In addition, see Permissible Dose from External Sources of Ionizing Radiation, handbook 59, Department of Commerce, National Bureau of Standards, September 24, 1954.

MG. PER CU. M.=milligrams of dust, fume, or mist per cubic meter of air.

Mineral Dusts

SUBSTANCE	M.P.P.C.F.
Alundum (aluminum oxide)	50
Asbestos	5
Carborundum (silicon carbide)	50
Dust (nuisance, no free silica)	50
Mica (below 5 percent free silica)	20
Portland cement	50
Talc	20
Silica:	
High (above 50 percent free SiO_2)	5
Medium (5 to 50 percent free SiO_2)	20
Low (below 5 percent free SiO_2)	50
Slate (below 5 percent free SiO_2)	50
Soapstone (below 5 percent free SiO_2)	20
Total dust (below 5 percent free SiO_2)	50

M.P.P.C.F.=Millions of particles per cubic foot of air.

TENTATIVE THRESHOLD LIMIT VALUES

The following values are suggested for further consideration before being presented for adoption as established values. (An asterisk * marks materials added in 1955 and for which bibliographical material has been prepared. The other materials appeared in the 1954 report.) It is proposed that the entire list will be presented for adoption at the meeting of the American Conference of Governmental Industrial Hygienists in 1956, if no reason to the contrary is forthcoming.

Reference material has been prepared on each of the following substances and, though in some instances it is rather meager, it is available for distribution. The committee welcomes suggestions of substances to be added and also comments, additional references, or reports of experience with these materials.

Aldrin (1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-dimethanonaphthalene)	0.25	mg/M³
Allyl alcohol	5	p.p.m.
Allyl propyl disulfide	2	p.p.m.
Ammate (ammonium amidosulfate)	15	mg/M³
Benzyl chloride	1	p.p.m.
Butyl amine*	5	p.p.m.
Butyl mercaptan	10	p.p.m.
Calcium arsenate	0.3	mg/M³
Chlordane (1,2,4,5,6,7,8,8-octachloro-3a,4,7,7a-tetrahydro-4,7-methanoindane)	2.0	mg/M³
Chlorine trifluoride*	0.1	p.p.m.
Chlorinated diphenyl oxide*	0.5	mg/M³
Crag Herbicide (sodium-2,4,dichlorophenoxy ethyl sulfate)	15	mg/M³
2,4-D(2,4-dichlorophenoxyacetic acid)	10	mg/M³
D. D. T. (2,2-bis-(*p*-chlorophenyl)-1,1,1-trichlorethane)	2.0	mg/M³
Diacetone alcohol (4-hydroxy-4-methyl pentanone-2)	50	p.p.m.
Diborane*	0.1	p.p.m.
Dieldrin (1,2,3,4,10,10-hexachloro-6,7, epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-dimethanonaphthalene)	0.25	mg/M³
Difluorodibromomethane*	100	p.p.m.
Diisobutyl ketone	50	p.p.m.
EPN (ethyl-*p*-nitrophenyl thiono benzene phosphonate)	0.5	mg/M³
Ethyl mercaptan	250	p.p.m.
Ethylene diamine*	10	p.p.m.
Ethylene imine*	5	p.p.m.
Ferro vanadium dust	1	mg/M³
Furfural	5	p.p.m.
Furfuryl alcohol*	200	p.p.m.
Hydrazine*	1	p.p.m.
Hydrogen bromide*	5	p.p.m.
Hydrogen peroxide, 90 percent*	1	p.p.m.
Hydroquinone*	2	mg/M³
Isopropylamine*	5	p.p.m.
Lead arsenate	0.2	mg/M³
Lindane (hexachlorocyclohexane, gamma isomer)	0.5	mg/M³
Malathon (0,0-dimethyl dithio phosphate of diethyl mercaptosuccinate)	15	mg/M³
Methoxychlor (2,2,diparamethoxyphenyl-1,1,1,trichloroethane)	15	mg/M³
Methyl acetylene*	1,000	p.p.m.
Methyl isobutyl carbinol (methyl amyl alcohol)	25	p.p.m.
Methyl mercaptan	50	p.p.m.
Molybdenum		
(soluble compounds)*	5	mg/M³
(insoluble compounds)*	15	mg/M³
p-Nitroaniline	1	p.p.m.
Organo mercurials (as mercury)	0.01	mg/M³
Perchloromethyl mercaptan	0.1	p.p.m.
Phenylhydrazine	5	p.p.m.
Picric acid	0.1	mg/M³
Propylene imine*	25	p.p.m.
Pyridine	10	p.p.m.
Quinone*	0.1	p.p.m.
Sodium hydroxide	2	mg/M³
Sulfur hexafluoride	1,000	p.p.m.
Sulfur pentafluoride	0.025	p.p.m.
TEDP (tetraethyl dithiono pyrophosphate)	0.2	mg/M³
TEPP (tetraethyl pyrophosphate)	0.05	mg/M³
p-Tertiary butyl toluene*	10	p.p.m.
Tetrahydrofuran*	75	p.p.m.
Tetranitromethane*	1	p.p.m.
Titanium dioxide	15	mg/M³
Trifluoromonobromomethane*	1,000	p.p.m.
Vanadium		
(V_2O_5 dust)	0.5	mg/M³
(V_2O_5 fume)	0.1	mg/M³
Zirconium	5	mg/M³

BERYLLIUM: During the past few years, several papers have reported a limit of 2γ per cubic meter of air for beryllium. Among these is the paper by Van Ordstrand, H. S.: Berylliosis, A. M. A. Arch. Indust. Hyg. 10: 232–234, September 1954, and one by Sterner, J. H., and Eisenbud, M.: Epidemiology of Beryllium Intoxication, A. M. A. Arch. Indust. Hyg. 4: 123–151, August 1951. Conflicting data from industrial experience have caused the committee to postpone the suggestion of a threshold limit for this material. It is apparent that more epidemiological work is needed for the establishment of a definite view.

A summary report on refuse storage, collection, and disposal practices in 1,273 cities in 30 States, 1951–54.

Refuse Handling Practices in the United States

By MALCOLM C. HOPE, M.S., M.P.H., CHARLES C. JOHNSON, Jr., B.S. and LEO WEAVER, B.C.E.

THE sanitary storage, collection, and disposal of municipal refuse have been a community problem, in varying degrees, since men first banded together for protection. It is only in recent years, however, that the problem has begun to receive concerted attention and action.

Studies have shown that the sanitary handling of refuse is an important factor in controlling such disease vectors as rats, flies, and mosquitoes. The feeding of raw garbage to hogs has been shown to be not only an important factor in the chain of transmission of trichinosis to man, but also a primary mode of transmission of virus diseases of swine, such as vesicular exanthema. In certain metropolitan areas, disposal of refuse by burning in backyard or apartment-house incinerators has been singled out as a significant source of air pollution. The National Fire Protection Association has reported data indicating that in 1953 "rubbish, ignition unknown" ranked third among 26 known causes of fires in buildings. Furthermore, the public is becoming impatient with the nuisances and inconveniences fostered by inadequate and insanitary refuse-handling systems.

So that the extent of the refuse-handling problem might be better understood and the job which yet needs to be done planned accordingly, the Public Health Service has made an inventory of municipal refuse storage, collection, and disposal practices. During the period 1951 through 1954, data outlining practices of 1,273 cities in 30 States were obtained. These data are summarized in this report. Distribution of the cities according to population group is shown in the following tabulation:

Population group	*Number of cities*
1,000–4,999	765
5,000–9,999	237
10,000–24,999	160
25,000–49,999	55
50,000–99,999	23
100,000 or more	30
Unknown	3

Most of the data included in this inventory were collected by or through State health departments. These data were reported on a

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The inventory reported in this paper was initiated and carried on under the supervision of Ralph J. Van Derwerker and Eugene L. Lehr when they were with the Division of Sanitary Engineering Services. Mr. Van Derwerker is chief sanitary engineer officer of the United States Coast Guard, and Mr. Lehr is assistant chief, Sanitation Services Branch, Division of Indian Health, Public Health Service.

William Xanten, superintendent of sanitation of Washington, D. C., and William Foster, engineering editor of the American City Magazine, among others, assisted in preparing the inventory form.

special inventory form, which the Public Health Service made available to State health departments in 1950. The form, prepared with the assistance of the American Public Works Association and various individuals, had been designed to facilitate uniform collection of refuse-handling data. The rest of the data were secured from published reports of other surveys conducted during the inventory period by State health departments or other agencies concerned with refuse handling.

The data presented in this report must be interpreted with cognizance of two limitations. First, although data were received from 30 States, 98 percent of the cities surveyed were in 17 States located east of the Rocky Mountains. Second, certain of the communities reported on early in the inventory period undoubtedly had changed their practices by 1954. Nevertheless, the information presented may provide assistance in evaluating refuse-sanitation practices in the United States.

The data collected during the course of the inventory show encouraging trends, but they also indicate that, despite the long-standing problem of disposing of municipal solid wastes, the preponderance of the job still remains to be accomplished.

Regulations

Three hundred forty-two cities reported that they had regulations governing one or more of the three phases of refuse handling, namely, storage, collection, or disposal. However, because of the nature of the data on the remaining 931 cities, it was not possible to establish what percentage of the latter actually did not have regulations on refuse handling.

Of the 342 cities, 53 percent had regulations which governed all 3 phases. Twenty-two percent had regulations governing storage only, and another 10 percent had regulations covering storage and either collection or disposal. The remaining 15 percent had regulations controlling collection only, disposal only, or both of these.

Data on the enforcement of regulations were received from 260 cities. Fifty-three (20 percent) of these reported that the regulations were enforced by the police department; 34 (13 percent), by the public works department or the agency responsible for the collection of refuse; 40 (15 percent), by the health department; and 72 (28 percent) reported that enforcement was the joint responsibility of the health department and some other municipal department, such as the police or public works department. (The remaining 61 cities did not specify the enforcement agency.)

Definition of Terms

Refuse: All putrescible and nonputrescible solid wastes (except body wastes), including garbage, rubbish, ashes, street cleanings, dead animals, abandoned automobiles, and solid market and industrial wastes.

Garbage: Putrescible animal and vegetable wastes resulting from the handling, preparation, cooking, and consumption of food.

Ashes: The residue from the burning of wood, coal, coke, or other combustible materials.

Rubbish: Nonputrescible solid wastes (except ashes), consisting of both combustible and noncombustible wastes, such as paper, cardboard, cans, grass and shrubbery clippings, wood, glass, bedding, and crockery.

Storage Practice

Separation requirements. Data on separation requirements were received for 1,244 cities. In 488 (39 percent) complete separation of garbage, rubbish, and ashes was required. Combined storage of all refuse was permitted by 642 (52 percent), and 98 (8 percent) required only the separation of garbage from other refuse. Other requirements, such as separation of combustibles from noncombustibles, were reported by 16 cities (1 percent).

Types of containers. Data concerning the use of covered metal containers for storing refuse are given in table 1. It is encouraging to note that for garbage or refuse containing garbage about 85 percent of the reporting cities required the use of this type of container.

Size of containers. Of the 95 cities reporting on the size of containers used for storing resi-

Table 1. Percentage of reporting cities requiring covered metal storage containers

Class of refuse	Residential: Number cities reporting	Residential: Percent requiring covered metal containers	Commercial: Number of cities reporting	Commercial: Percent requiring covered metal containers
Garbage	138	83	119	84
Rubbish	26	58	14	50
Ashes	8	25	6	33
Combined refuse	171	87	131	86

dential garbage, only 12 (13 percent) permitted storage in containers larger than 30 gallons. Where combined storage of refuse was practiced, however, 43 (36 percent) of the 118 reporting cities permitted containers larger than 30 gallons. Table 2 shows the residential container-size requirements reported for each class of refuse.

Data on the size of containers used for commercial garbage from 69 cities showed that 28 (41 percent) required that containers be of 30 gallons or less. Thirty-two (46 percent) allowed the use of containers up to 40 gallons in size, and 9 (13 percent) permitted storage in containers larger than 40 gallons. Where combined storage of refuse was permitted, 57 of 98 cities required that containers be of 30 gallons or less, the remainder permitting the use of containers larger than 30 gallons in capacity.

Collection Practice

Frequency of collection. Tables 3 and 4 show the variations in the frequency of collection for the various classes of refuse according to season of the year. Of the 698 cities reporting on the summer collection of garbage or combined refuse in residential areas, 397 (57 percent) made collections at least twice a week. With respect to summer collection from commercial establishments, 352 (52 percent) of 626 cities reported that garbage or refuse containing garbage was collected daily. An additional 138 (29 percent) collected this material at least twice a week.

As might be presumed, during the winter fewer cities provided twice-a-week collection. However, 646 (93 percent) of the 691 cities reporting on winter collection of garbage or combined refuse in residential areas provided at least once-a-week pickup of this material.

Point of collection. Information was obtained from 448 cities on the point at which the collection crew was authorized to pick up refuse. As shown in table 5, 190 (43 percent) specified either the curb or the alley, or both, as the pickup point. Two hundred one (45 percent) reported various combinations of curb, alley, front houseline, and rear houseline as being acceptable pickup points.

Responsibility for collection. In table 6 are the data concerning the agencies responsible for the collection of municipal refuse. It is interesting to note that, when each class of refuse is considered separately, there is a similarity between commercial and residential responsibilities. The responsibility for collection of garbage is fairly evenly distributed on a municipal, contract, and private basis.

Combined collection of refuse in more than 50 percent of the communities was accomplished by private or individual arrangements. Analysis of the data showed that 373 of the 393 cities (95 percent) reporting private residential collection were in the 1,000–9,999 population group. On the other hand, only 20 of 112 cities (18 percent) having a population of 10,000 or more utilized private collection, and 79 (68 percent) utilized municipal collection. A similar relationship between population and responsibility for collection was found upon analysis of the data on combined collection of refuse in commercial areas.

Table 2. Size of containers for residential refuse

Class of refuse	Number of cities reporting	Number reporting maximum size of—: Less than 10 gallons	10–19 gallons	20–30 gallons	Number allowing more than 30 gallons
Garbage	95	6	20	57	12
Rubbish	22	0	2	10	10
Ashes	9	1	2	4	2
Combined refuse	118	0	13	62	43

Table 3. Frequency of refuse collection in residential areas

Class of refuse	Summer collection: Number of cities reporting	Less than 1 per week	1 per week	2 per week	More than 2 per week	Winter collection: Number of cities reporting	Less than 1 per week	1 per week	2 per week	More than 2 per week
Garbage	284	2	85	151	46	281	3	137	107	34
Rubbish	99	14	35	38	12	98	14	46	30	8
Ashes						19	4	8	5	2
Combined refuse	414	42	172	157	43	410	42	202	127	39

Table 4. Frequency of refuse collection in commercial areas

Class of refuse	Summer collection: Number of cities reporting	Less than 1 per week	1 per week	2 or more per week but less than daily	Daily	Winter collection: Number of cities reporting	Less than 1 per week	1 per week	2 or more per week but less than daily	Daily
Garbage	239	2	29	90	118	236	2	53	68	113
Rubbish	94	10	9	24	51	93	10	11	24	48
Ashes						16	3	4	3	6
Combined refuse	387	27	60	93	207	387	26	71	85	201

Types of vehicles. Data on the types of vehicles used in collecting refuse were received from 337 cities having municipal collection. Of these, 157 (46 percent) relied on open vehicles for the collection of refuse. About 10 percent reported the use of covered vehicles, and another 10 percent, mechanical-compactor-type vehicles. The remaining 34 percent reported the use of combinations of these types of vehicles.

Data from 82 cities using contract collection showed that 49 (60 percent) used open vehicles. Only 12 (15 percent) reported the use of the mechanical-compactor type either exclusively or in combination with other types. Data from 147 cities having private collection arrangements revealed that 111 (75 percent) relied on open vehicles. Only 11 (10 percent) reported the use of the mechanical-compactor type either exclusively or in combination with other types.

Table 5. Designated point of refuse collection in 448 cities

Point of collection	Number	Percent
Curb or alley, or both	190	43
Front houseline	10	2
Rear houseline	33	7
Combination of above points	201	45
Other	14	3

Method of financing. Table 7 lists the data reported on the method of financing refuse collections. Of the 633 cities that specified their method of financing, 382 (60 percent) indicated that they relied solely on the fee system. An additional 50 (8 percent) reported the use of both special fees and the general tax fund. An analysis of the data by population group revealed that of the communities in the 1,000–4,999 category 75 percent relied wholly or in part on the fee system; of those in the 5,000–9,999 category, 62 percent; of those in the 10,000–24,999 group, 63 percent; of those in the 25,000–49,999 category, 48 percent; of those in the 50,000–99,999 category, 34 percent; and of the cities with 100,000 or more population, 39 percent.

Miscellaneous data. Of 561 cities providing information on the private collection of garbage for hog feed, 464 (83 percent) specified that they permitted this practice. However, during the period of this inventory, many communities

Table 6. Responsibility for collection of refuse

Class of refuse	Number of cities reporting	Municipal (percent)	Municipal contract (percent)	Private (percent)
Garbage:				
Residential	574	32	38	30
Commercial	569	30	38	32
Rubbish or ashes:				
Residential	138	64	17	19
Commercial	136	58	17	25
Combined refuse:				
Residential	740	37	10	53
Commercial	740	35	9	56

Table 7. Method of financing refuse collection, according to population group

Population group	Fees	General taxes	Both fees and taxes	Method not specified
1,000–4,999	282	103	21	359
5,000–9,999	52	40	11	134
10,000–24,999	33	25	9	93
25,000–49,999	9	13	3	30
50,000–99,999	2	8	2	11
100,000 or more	4	11	3	12
Total	382	201	50	640

undoubtedly experienced considerable change in the methods by which agencies or individuals arranged to handle garbage ordinarily fed to swine. In 1952, the feeding of raw garbage to swine was shown to be a primary cause of the widespread outbreak of the virus disease of swine, vesicular exanthema, which occurred in that year. By 1955, all but two States had regulations requiring the disinfection of garbage fed to swine. The United States Department of Agriculture reported that as of June 30, 1955, 83 percent of almost 1½ million garbage-fed swine on more than 13,000 garbage-feeding establishments were fed cooked garbage.

With regard to the installation of garbage grinders, 28 of 503 reporting cities (6 percent) prohibited the installation of these devices. Of interest was the fact that 21 of the 28 cities were in the 1,000–9,999 population category.

Of 688 cities reporting on scavenging practice (during the storage or collection period), 139 (20 percent) reported that scavenging was not permitted. Of the cities reporting that scavenging was permitted, almost 90 percent indicated that no license was required.

Disposal Practice

All 1,149 cities reporting on disposal practice indicated the use of one or more of four methods of disposal: incineration, sanitary land fill, open dump, and hog feeding. Ninety-one of the cities (8 percent) reported the use of incineration and 114 (almost 10 percent) reported the use of the sanitary land fill. Table 8 gives the number of cities, according to population category, using each of the four methods.

Table 8. Number of cities reporting use of specified methods of refuse disposal, according to population group

Population group	Number of cities reporting	Incineration	Sanitary land fill	Open dump	Hog feeding
1,000–4,999	667	18	32	539	159
5,000–9,999	221	26	24	131	80
10,000–24,999	156	18	19	76	73
25,000–49,999	53	12	16	25	21
50,000–99,999	20	6	11	7	8
100,000 and over	29	11	11	16	7
Total	[1] 1,149	91	[2] 114	[3] 796	348

[1] Population group not specified for 3 cities. [2] Population group not specified for 1 city. [3] Population group not specified for 2 cities.

Of significance was the fact that 616 (54 percent) of the 1,149 cities reported the use of the open dump as their only means of disposal. Another 130 (11 percent) reported the use of a combination of the open dump and hog feeding as their only means of refuse disposal.

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